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Notes on the Anatomy and Relationships of the Ocean Sunfish (*Mola mola*)[1]

By William K. Gregory and Henry C. Raven

ALTHOUGH the anatomy of the ocean sunfish has been described by several authors, the receipt of a fresh specimen from the New York Aquarium gave one of us (H. C. R.) an opportunity to make a dissection of this most curiously specialized fish and led to the following notes and comparisons with *Diodon* and other related plectognaths.

Surface Features

The fish was caught off Sandy Hook in the lower bay of New York on September 15, 1932. It weighed 175 pounds, which is only about one-tenth the maximum weight recorded by Jordan and Evermann.[2] Nevertheless it was a male with fully developed testes. Hence it seems that *Mola* probably goes on increasing in weight long after the testes attain maturity. The total height from the tip of the dorsal fin to the tip of the anal fin is about 64 inches, the total length 47 inches. Thus the total height is about 1.36 times the length. In the front view the body is deep and keel-like below with a knife-like lower edge in front of the vent. The thickness increases dorsally and there are prominent swellings above the eyes.

The ordinary axial musculature is absent and the body is enveloped in a very thick rubber-like skin from two to two and a half inches in thickness. Hence flexure of the body must be slight and movement must be largely confined to side-to-side waving of the high median fins and gentle undulations of the scalloped border of the abbreviated deep tail, which serves also as a rudder. Lateral stability is aided by the wide, more or less truncate pectorals, which have a long range of abduction and adduction.

The entire surface of the skin is covered with close-set denticle-like structures, not more than a millimeter in length, which stick out straight from the skin. The thickened skin resembles cartilage in density, but is more flexible; it is said to contain collagen. The surface of the body shows four distinct flexure lines; the main one begins at the base of the caudal fin, the others at the bases of the dorsal, anal and pectoral fins. Immediately above the mouth the skin is much hardened and more dense than elsewhere and forms a knob, like the bow of a streamlined ship.

Median Fins

The very high caudal fin is separated from the dorsal and anal fins by notches. It contains 7 stiff dermal rays below the vertebral column and 6 dorsal to the tip of the column. Each of these dermal rays terminates at a large notch on the posterior border of the tail, except that at the notch directly posterior to the end of the vertebral column two dermal rays terminate, as on the middle of a spreading homocercal tail of the type seen in

[1] Paper read at the New York meeting of the Society, May, 1934.
[2] Fishes of North and Middle America, pt. 2. *Bull. U. S. Nat. Mus.*, 47 (2), 1898: 1754.

Diodon. At the termination of each caudal dermal ray there is an ossicle of extremely hard, probably calcareous material, to which the dermal rays are attached; there is one of these ossicles at each notch of the scalloped border of the tail. Two dermal rays are attached to the largest of these ossicles, which is about 1¼ inches in diameter, and which is the one in line with the termination of the vertebrae.

A single tendon is attached on each side to the base of each caudal dermal ray with the exception of the second subvertebral ray, to which two tendons are attached. The dorsal tendon of this pair terminates a slender terete muscle taking origin from the last or next to the last vertebra, beneath the muscle which goes to the first subvertebral caudal ray. Each caudal ray is supported by three cartilaginous pieces in series: the inner one, a large rod representing an hypural; next a tiny ossicle, at the point of greatest flexure of the fin; then the third piece, which is wedge-shaped and is straddled by the forked base of the dermal ray, and which therefore supports the border of the movable tail fin.

It has been debated in the literature[3] whether this so-called caudal fin is a true caudal or whether it is a gephyrocercal tail arising from the fusion of the posterior portions of the dorsal and anal fin. The facts that the column is withdrawn from this region, that the muscles and dermal rays are in series with those of the dorsal and anal fins, that at first sight the hypural bones seem to be absent and that there are none of the ordinary complex, oblique tail muscles, at first inclined us to think that the true caudal fin had been lost. But many other facts point to the opposite conclusion that the true tail fin of *Mola* has shared the excessive vertical growth of the dorsal and anal fins. First, none of the near relatives of *Mola,* namely the diodontids and tetraodontids, show any tendency toward the development of a gephyrocercal tail. Secondly, the tail muscles of *Diodon* as described by Grenholm (p. 239) afford the clue to the origin of the enormous tail muscles of *Mola,* from the "lateralis" mass of flexors, after the atrophy of the transversus, interradial and hypaxonic muscles; while the conditions in *Diodon,* as observed by us in a dissection, suggest how the great overgrowth of the tail, together with the atrophy of the column, would leave the tail virtually free of the column as we find it in *Mola.* Thirdly, the earlier larval stages of *Mola* and *Ranzania,* as figured by Steenstrup and Lütken[4] and by Schmidt,[5] always show a very distinct caudal fin with no sign of the gephyrocercal condition, which, after all, is known only in long-bodied fishes.

The massive pachydermatous covering of the tail can move freely only at the flexure lines but otherwise is as stiff as a rudder, so that it must act much like Breder's ostraciiform model.[6]

The huge dorsal and anal fins form the chief locomotor organs of the body and their enormously hypertrophied muscles occupy most of the space on the back and sides usually filled by the segmental muscles of the backbone and ribs. The lateralis muscles of the dorsal fin extend forward on either

[3] See Ake Grenholm, "Studien über die Flossenmuskulatur der Teleostier," Upsala, 1923: 243.
[4] Kong. Danske Vidensk. Selsk. Skrifter, 9, 1898, pl. 4.
[5] Medd. Havunders. Kjobenhavn, (Ser. Fisk.) 6 (6): 1–13, fig. 1–15, pl. 1.
[6] Locomotion of Fishes. Zoologica, 4, 1926: 170.

side above the column, and are fastened to the top and back of the skull. They also take origin from the under surface of the massive skin. The anal fin muscles extend dorsad and take origin from the ventral and lateral sides of the vertebral column. Together the huge dorsal and anal fin muscles restrict the body cavity posteriorly.

The separateness of the tendons and distal portions of the muscles attached to the dermal rays of the dorsal and anal fins, as well as the fine lines on the skin parallel to the dermal rays, indicates flexibility for undulatory movement of these fins. We therefore cannot fully agree with Wahlgren (quoted by Grenholm, p. 245) that the dorsal and anal fins move only as wholes and not by their separate rays. We agree rather with Grenholm that while the rays retain some independence, yet the principal movement is of the fin as a whole. The moderate undulatory mobility of the dermal rays of the dorsal, anal and pectoral fins is evidenced by the thinness of their coating of collagenous skin, whereas the lack of mobility of the caudal fin rays is indicated by the great thickness (2 inches) of the collagenous skin over this region.

The atrophy of the axial musculature is reflected in the absence of true ribs. Whereas in normal fishes the axial musculature comprises perhaps 90 per cent of the musculature of the fish, in *Mola* we have been unable to find any axial musculature in the true sense, *i.e.*, those muscles having both origin and insertion in the elements of the column including the ribs. All the muscles attached to the vertebral column in *Mola* are muscles which operate the fins, principally the dorsal and anal. But of course all these were originally derived from the myomeres.

Pectoral Girdle and Fins

The pectoral girdle and fins of *Mola* are fundamentally similar to those of *Balistes* as figured by Grenholm (p. 223), but owing to the high position of the pectoral fins and to the great dorsoventral extension of the coracoid and cleithrum, the abductor superficialis and profundus muscles are greatly elongate, giving a long range of action of the pectoral. To the expanded top of the cleithrum is attached the stout supracleithrum. We could not find a suture between the superior and the inferior postcleithrum. The latter is fastened by connective tissue to the medial surface of the base of the pectoral fin and, together with a long process from its lower end that extends on to the lateral surface of the fin, ties the whole girdle and fin to the supracleithrum and thus to the epiotic region of the skull. The bony process that is lateral to the base of the pectoral is continuous with the inferior postcleithrum. To the lower end of the latter is attached a small muscle, inserted in the inner surface of the skin, which muscle is evidently homologous with the "retractor postclavicularis musculi recti," described by Parr (1927: 253) in *Sphaeroides*. The "lateral process" above noted is merely a process from the inferior postcleithrum. It definitely does not represent that blade of the cleithrum in *Diodon* which extends over the lateral face of the pectoral fin base, but it serves much the same function and may have grown forward as the cleithrum retreated.

The coracoid of *Mola* is elongated ventrally and is connected below with

the cleithrum by a short cartilaginous strip. Probably this symphysis of the opposite cleithra represents the ventral symphysis of the peculiar type of cleithrum seen in *Diodon,* in which the concave fossa for the abductor superficialis and abductor profundus muscles has been greatly produced dorsoventrally at the expense of the symphyseal end of the region, below the abductor fossa.

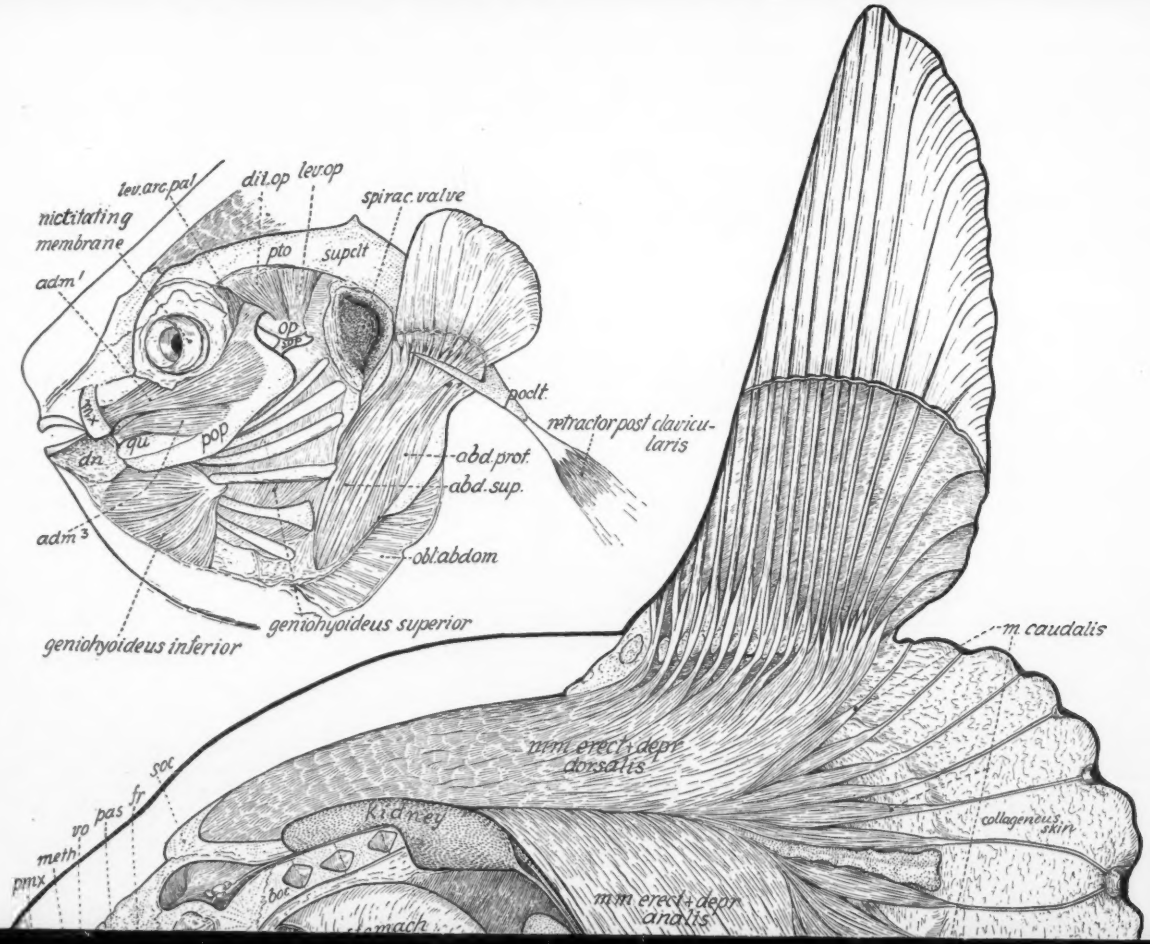
The upper end of the coracoid has a fan-shaped expansion upon which rest three large pterygials and one small outer pterygial. The scapula seems to be represented by a vestigial bone which is crowded between the expanded first pterygial and the posterior recurved border of the cleithrum. The true scapular foramen, carrying its nerve and blood vessel, is extremely small and far out of line with the very large interpterygial foramina (cf. Starks[7], 1930: 64). Thus in *Mola* the scapula is far more reduced than it is in *Diodon*; on the other hand, the first pterygial, like the second and third, is large, whereas in *Diodon* it is reduced. The figure of the pectoral girdle and fin by Steenstrup and Lütken (p. 92) shows only three actinost-like elements, but our *Mola* definitely shows four actinosts (pterygials), plus the vestigial scapula.

Throat Muscles

At its lower end the pectoral girdle is tied to the stout hyoid arch and mandible by several longitudinal and oblique muscles. Allis[8] in his monograph on *Scomber* (pl. 8) applies the names pharyngo-clavicularis externus, pharyngo-clavicularis internus and sterno-hyoideus to muscles running from the anterior border of the cleithrum to the ceratobranchial and urohyal respectively. Apparently these muscles are also represented in *Mola* even though the urohyal is reduced to a thin membranous vestige. As to the muscles on the underside of the throat, those of *Mola* may be identified by comparison with Allis's description and plates of these muscles in *Scomber,* which we have checked also in *Epinephelus.* Two sets of muscles arise from the two inner parts of the mandible and of the ceratohyal and basihyal. The deeper pair, the hyohyoidei of Allis, arise from the sides of the basihyal and then cross over to be inserted on the branchiostegals of the opposite sides. The more superficial muscles, the geniohyoidei of Allis, arise from the outer side of the basihyal and pass outward and backward to be inserted on the lateral surface of the branchiostegals and ceratohyal of the same side. They form a great web of muscle between the branchiostegals. The homologue of the intermandibularis has shifted to the ceratohyal and base of the first branchiostegal but keeps its relation to the longitudinal muscles. All these muscles doubtless cooperate in the system of respiratory and circulatory movements.

To the anterior border of the cleithrum is attached the web of muscular tissue between the branchiostegals, so that the usual opercular cleft is reduced to the small pseudospiracular opening described below. The deep ventral muscles of the throat above mentioned, attached to the anterior lower part of the cleithrum, probably pull the jaws and floor of the throat downward, thus expanding the oral cavity while the superficial and transverse muscles of the throat and branchiostegal rays constrict this cavity and tend to force

[7] The Primary Shoulder Girdle of the Bony Fishes. *Stanford Univ. Publ.,* (Biol. Ser.) 6 (2), 1930: 64.
[8] Journ. Morph., 18, 1903: 45–328.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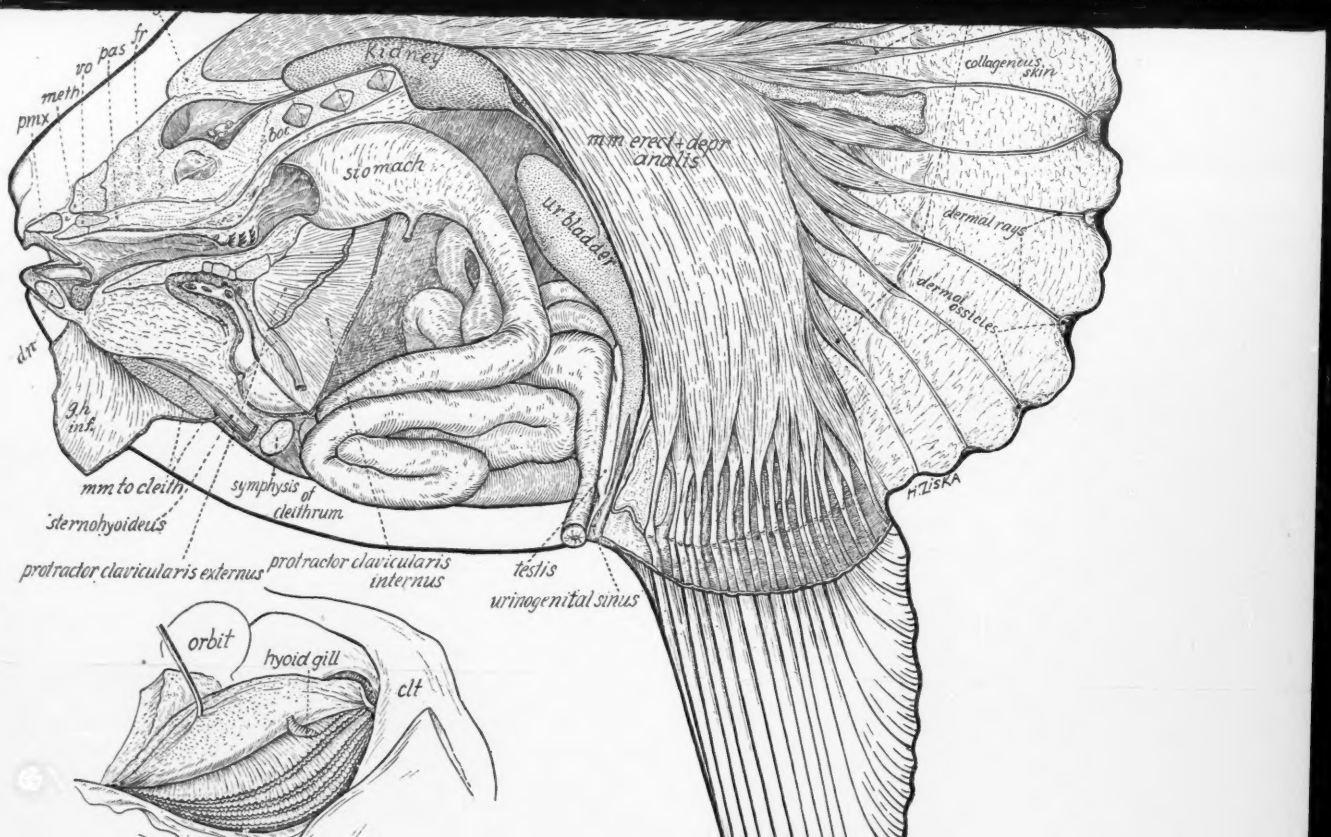
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MOLA MOLA

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the water out through the pseudospiracular opening, cooperating with the levators and dilatators of the operculum.

Branchial and Opercular Region

The inner gill openings are restricted, for whereas the gills are 17 inches in length, the four openings from the mouth into the gills are simply slits, each 2 inches long. In connection with the powerful muscles of the throat and opercular fold these narrow inner gill openings must cause a strong flushing of water within the gill chamber.

In contrast with the great size of the gills themselves the opercular opening is reduced to a narrow slit 3 inches in height, guarded by a valve-like flap of thick skin. A lunate groove marks the front end of the movable flap. The very small opercular bone, which is but two inches in length, is deeply buried beneath the thick skin, about 3 inches in front of the opercular slit. Nevertheless the opercular is operated by two broad dilatator and levator muscles, which thus indirectly cause the opercular region to expand a moment before the opercular flap is forced open.

The subopercular, if present, could not be separated from the interopercular. The interopercular is reduced to a long thin tracker connecting the angle of the mandible with the operculum. The same arrangement is seen in *Tetraodon* and *Chilomycterus*. When the jaw is shut by the adductor mandibulae this tracker pulls down on the operculum, tending to open its chamber.

Mouth Parts

The adductor muscles are massive and fleshy with very short or no tendons. Only two branches are present. This contrasts with the conditions in the diodontids, in which all three branches of the adductor are greatly expanded, adductors 2 and 3 have very strong tendons, and adductor 3 is shifted to the front and inner side of the eye. No doubt the jaw muscles of *Mola* are more or less reduced in connection with its diet of very soft material. In our specimen the digestive tract contained quantities of green algae with medusae. Dr. E. W. Gudger states that Mr. Vinal Edwards, the well known collector at Woods Hole, found that *Mola mola* fed entirely on ctenophores and medusae.[9] D'Arcy W. Thompson,[10] on the other hand, cites records of the fish's feeding on the leptocephali of eels.

The beak is much more slender and delicate than that of *Diodon,* but is formed in the same way, that is, by coalescence of the dentigerous elements into two parts: a marginal or cutting edge and a central mass; the latter, however, is vestigial in *Mola,* without laminae and represented by scattered hard, minute, cylindrical teeth imbedded in spongy tissue.

The jaw parts, like all other bones of the skeleton, are largely cartilaginous and when dried shrink to only a fraction of their normal size; they are composed mostly of fibrous longitudinal trabeculae that radiate from the centre of growth. The articular is received into a large notch in the dentary, as in *Diodon,* to the mandible of which that of *Mola* is closely related. In the upper jaw the maxilla is suturally united to the premaxilla

[9] Hargitt, Charles W. "The Medusae of the Woods Hole Region." *Bull. U. S. Bur. Fish.,* 24, 1904 (1905): 25.

[10] Scottish Naturalist, 1918: 46; Nature, 93, 1914: 166.

and the whole arrangement is fundamentally similar to that in *Diodon,* including the presence of horizontal hinge-like surfaces on the palatines. The ascending processes of the premaxillae, vestigial in *Diodon,* are absent in *Mola,* there being merely a convexity in the dorsal midline. The upper jaw is movably articulated with the mesethmoid by connective tissue.

In *Diodon* a deep funnel-shaped distal expansion of the parasphenoid receives the mesethmoid and the vomer. In *Mola* this arrangement is obscured by the weakness of the parasphenoid, which frays out into an irregular edge. The mesethmoid, very small in *Diodon,* is very large in *Mola* and forms the median pivot for the upper jaw.

Miscellaneous Notes

The most striking characteristic of the skeleton is the great reduction of bony tissue. Ossification is so weak that the material, when cut with a knife, resembles cartilage. The skeleton, when dry, for the most part shrinks into thin, delicate and fibrous or spongy pieces. The skeleton is largely pervaded by cartilage. Collagenous material swells up the skin to great thickness and forms a rubber-like armor all over the body.

Considering the huge size of the fish, the eye of *Mola* is fairly large and well developed.

The dermal opening of the eye measures 1¾ inches in diameter. At least one-half the eye is hidden from view in the dead specimen by a well developed nictitating membrane, which arises on the anterodorsal margin of the eye and extends over the posterior portion, terminating directly below its origin on the anterior ventral portion of the eye. This muscular membrane forms a double fold, which is rather thick and appears to contain elastic as well as muscular tissue.

The skull of *Mola* has recently been figured and described by one of us.[11]

The brain of *Mola* is extremely small for the size of the skull and brain cavity. According to Vignal,[12] the spinal cord is very short and ends posteriorly in a cauda equina of fine nerves. The lobi inferiores of the midbrain are much enlarged.

The viscera of *Mola* have been well described by Cleland[13] and others. They seem to be in general similar to those of *Chilomycterus,* in spite of the wide difference in food habits.

Relationships

It is well known that in the larval stages *Mola* is covered with long spikes and is more or less *Diodon*-like in appearance. The fusion of opposite halves of the jaws into single upper and lower beaks is likewise a strong point of resemblance. The wide differences in the jaw muscles (see page 148) may readily be referred to the degenerate food habits of *Mola.* In view of the presence of a vestigial muscle connecting the postcleithrum with the skin (page 147) it may also be assumed that *Mola* has lost the power of inflation

[11] Gregory, William K. *Trans. Amer. Philos. Soc.,* 23 (2), 1933: 294.

[12] Note sur l'anatomie des centres nerveux du mole, *Orthagoriscus mola. Arch. Zool. Exp. et Gén.,* 9, 1881: 370–386, pl. 21, 1 fig.
Sur les lobes accessoires de la moelle du mole (*Orthagoriscus moia*). *Comptes Rendus Hebdomadaires Séances et Mém. Soc. Biol.* (8) 3: 144–146, 1 fig.

[13] On the Anatomy of the Short Sunfish (*Orthagoriscus mola*). *Nat. Hist. Review,* 1862: 170–185, pls. 5 and 6.

as well as the swim bladder possessed by all lower plectognaths. In fact the resemblances with the diodontids are far-reaching and justify the systematists in bracketing the Molidae with the Diodontidae in the subordinal group of Gymnodontes.

Orthagoriscus (*Mola*) is recorded as fossil only in the Pliocene of Belgium,[14] and possibly in the lower Miocene of Patagonia, while the diodontids date back to Monte Bolca times (Upper Eocene). Hence it is possible that the molids branched from the diodonts only during the Tertiary. Nevertheless certain differences today are rather profound, especially the reduction of the scapula to a vestige in *Mola,* together with the enlargement of the first pterygial, which is much reduced in *Diodon.*

On the whole our evidence tends to support the view of D'Arcy Thompson[15] that *Mola* (*Orthagoriscus*) represents a greatly deepened derivative of a *Diodon*-like ancestor in which the deepening has been accelerated toward the posterior end of the body. This hypothesis makes it easy to understand how the rapidly deepening tail muscles could be nearly freed from the diminishing vertebral column (see page 146 above).

American Museum of Natural History, New York City.

Sex Recognition in the Sunfish, *Eupomotis gibbosus* (Linné)

By G. K. Noble

VERTEBRATE animals exhibiting a sexual dichromatism usually display during courtship. Darwin (1871) assumed that the bright colors of the males were attractive, or at least stimulating, to the females. There is evidence however, in both lizards (Noble, 1934) and birds (Allen, 1934) that the conspicuous colors may serve as intimidating devices rather than allurements. The significance of color in the courtship of fishes has been studied by several investigators. A display is employed in many species to intimidate rivals. Nevertheless some fishes, at least, do not recognize sex on a basis of color differences. Reighard (1913) found that in the log-perch (*Percina caprodes*) where there is a marked sexual dichromatism: "Young males in full color were often pursued by other males, and were apparently distinguished from them only by their failure to stop and behave like females. By the experimental substitution of a male for a female it was shown that if such a male were moved rapidly and then stopped on the bottom it was treated by other males as a female."

Reighard did not carry this analysis of courtship in the log-perch further and, although some others, as Reeves (1907) and Lissmann (1932) have emphasized the importance of movement in the sex recognition of other species of fish, no one has attempted to work out experimentally the importance of body form and size which must enter into the problem to some extent.

Instead of beginning where Reighard left off I have studied the courtship

[14] Woodward, A. S. Catalogue of Fossil Fishes, British Museum, pt. 4, 1901: 576.
[15] On Growth and Form. Cambridge, 1917: 751.

in another species of fish which was more available to me. The courtship of the common sunfish, *Eupomotis gibbosus,* is well known, having been described by Reighard (1902), Fowler (1923), Adams and Hankinson (1928) and others. I have had several dozen males under observation at Haworth and Saddle River, New Jersey, during July 1934. As is well known, the male is more brightly colored than the female. Although the body tones of both sexes vary considerably according to the light and vegetation available at the nesting site, the females when approaching the redd invariably have more conspicuous vertical bars on the sides of their bodies than have the males. These bars fade rapidly when the fishes are removed from the water. Nevertheless they form a ready means of sex determination when the unmolested fish are courting.

In spite of this sexual difference in color the sunfish, like the log-perch, does not discriminate between the sexes, by this means. Adult males and females stunned and slowly pulled toward a male guarding a recently constructed redd, are welcomed in the same manner. The guarding male raises his opercula and fins slightly. As soon as either stunned fish is brought in contact with his body he begins to circle over the redd poking the stunned fish gently with his snout as he turns. If the stunned fish is turned slowly, the guarding fish circles in the same manner as during oviposition, butting and gently biting as he moves.

When a male in full breeding color was tethered on a string only one inch long directly over the center of the redd, the owner of the redd returned and brought his tail gently in contact with the snout of the tethered fish exactly as he would have done had it been a female. The free male then circled in the usual manner of courtship. This experiment repeated in several redds showed that the male sunfish, unlike the male *Sceloporus undulatus* (Noble, 1934), is unable to distinguish the sex of a quiescent adult of his own species by appearance alone.

The moment of ejaculation is normally controlled by the female who tilts at an angle of approximately 45° to the vertical, and brings her vent region in contact with the male's at the same time giving 2 or 3 (rarely more) short lateral thrusts with her abdomen. At this moment some eggs and milt are ejaculated. One female under observation laid 75 times during 5 minutes, tilting over at each oviposition. The male maintains his upright position during the entire procedure but continues to swim in small circles butting her tail and sometimes the sides of her body with his snout.

In striking contrast to the behavior of a male toward a stunned fish of either sex, the response of a male to his own mirror image is a vigorous attack. Mirrors placed vertically to the bottom on the edge of the redd soon called forth a maximum erection of the opercula followed by a rush of the fish with open mouth toward the mirror. This is in agreement with the observations of Lissmann (1932) on *Betta splendens* and is to be explained on the assumption that the male movements, chiefly the display of opercula and fins of the image, call forth a more vigorous display and finally an attack by the guarding male.

That smell does not enter at all into the problem of sex recognition of the sunfish as it does in snakes was proved by a series of experiments with

adult and immature fish of both sexes, both dead and preserved in formalin. Further a series of plasticine models, painted with orange and green lacquer, of drawings roughly colored with crayon and finally with merely a series of leaves having the approximate dimensions of the guarding sunfish had the same effect. All these objects induced the circling, butting and gentle biting characteristic of courtship. In one instance the male became so much interested in circling with a paper drawing of a male sunfish that he allowed himself to be picked up in a small scoop.

It was clear from the response of a series of males to the objects mentioned above that tactile stimulations, supplemented probably by stimulations of the lateral line organs, were directly responsible for the circling movements practiced by the male during oviposition. There is, however, a definite limit to the size of objects which will induce the circling. As the width of the stimulating object decreases, it becomes increasingly difficult to evoke the movements. I found that I could induce some circling with a flattened stick one half inch wide, but I failed with a stick of the same green color three-eighths of an inch wide. I also failed with a copper wire. Since the success of any trial depends to a large extent on the skill with which the object is manipulated it is not unlikely that more flexible objects would give different results. At the other extreme, leaves or other objects distinctly larger than the guarding fish invariably induced a flight response. Here vision was probably influencing the result. At the small extreme it may have been the character of the stimulations made by narrow objects which was inadequate. However, a narrow object frequently caused the male to flee and vision may have had some influence at this limit as well.

The male does not force the female to circle over the redd. Even when the female moves within the narrow orbit traced by the male she swims parallel with the male and stimulates him by gentle flaps with her tail as well as by the abdominal thrusts of oviposition. If, however, the female moves away from the redd, he may follow her with "ears" erected. Since the male in circling butts the female's tail and bites her gently from time to time each member of the circling pair stimulates the other. The female may also bite the male as he turns but in the pairs studied most closely the male butted and bit more frequently than did the female.

Severe biting was a sign of unsatisfactory courtship. This was shown most clearly when formalin preserved fishes were manipulated on copper wires over the redd. Bringing the abdomen of such fish in contact with that of the guarding male would invariably induce a more rapid circling. Merely butting the live male with the snout of the preserved specimen while turning it in a circle would usually lead within a few minutes to a vigorous biting by the male. There is however considerable variation in the pugnacity of the males. At Saddle River 3 guarding males in one pond failed to bite a formalin-fixed male which when manipulated in a vertical position induced them to circle for long periods over their redds.

In spite of this variation, the males as a group were stimulated to circle over the redd by slow movements of the stimulating object or by touching the base of their tails. They were induced to bite severely by frequent butting of their sides or by failure to make contact with their abdomens.

Although males recognize males by their rapid movements and displays, the response of any one male to another is also conditioned by their distance from their respective redds. On one occasion a male 2 feet from his own redd vigorously attacked another male, but the same male when 4 feet from the redd swam peacefully along with another male. On frequent occasions it was seen that a male driven from his redd would not attack other fish until he returned.

A male guarding his redd can usually drive other males away merely by intimidating them with a display. On one occasion a male over an inch longer than a guarding male approached the latter's redd but immediately fled when the owner erected his "ears." The bright colors of the male sunfish, like the bright ventral tones of the lizard, *Sceloporus undulatus,* are primarily intimidating devices.

It cannot be stated, however, that the bright colors of the male have no influence on the female. On 3 occasions I witnessed females enter redds guarded by males. In each case the female darted quickly into the redd without waiting for the weak display the males first employed against all strange objects approaching the redd. The females began at once to circle with the males. In these cases the females never had the opportunity of witnessing the full display of the males. Nevertheless, the brightly colored male is a striking object when guarding his redd, and it is probable that the brighter males, because more conspicuous, would be visited more often by females. A count of the number of eggs in each redd would not settle the point since the smaller males are visited by smaller females. In *Sceloporus undulatus* the males guard log piles which are frequented by females for sunning purposes and there is no evidence of sexual selection in the Darwinian sense. How frequently females visit unguarded redds is not known, but these quickly become obscured by silt in the absence of the male. Hence if it should be shown that females are responding primarily to suitable places for egg-laying, these in turn are dependent on the male. Hence the conditions are different in lizard and fish. Whether or not a sexual selection actually occurs in the sunfish is difficult to determine in the field because of the difficulty of following the females. Laboratory observations on several species of fish indicate that movement of bright objects arrests attention. Hence it is probable that a true sexual selection may occur in the sunfish since the females would presumably move into the redds which attract their attention first.

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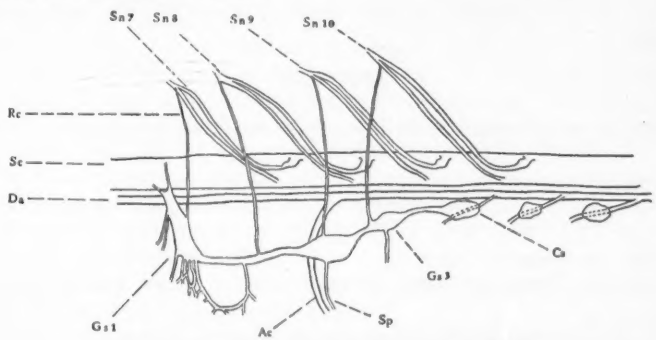
AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

The Anterior Trunk Ganglia of the Sympathetic Nervous System in *Squalus suckleyi*[1]

By SIDNEY MAYER, JR., and LAWRENCE E. GRIFFIN

DANIEL (1922) gave an excellent summary of the knowledge at that date of the condition of this part of the sympathetic system in elasmobranchs. The first trunk gaglion had been found to be the result of the fusion of several segmental ganglia with the most anterior suprarenal body. Communicating rami from the anterior spinal nerves and splanchnic fibers to the viscera had also been identified.



Anterior sympathetic ganglia of *Squalus suckleyi*

Our investigations have disclosed the following details of this system: the ganglia anterior to the head of the kidney were found inside of the posterior cardinal sinus and dorsal to the oesophageal end of the stomach; the more posterior ganglia were found, by opening the posterior cardinal veins, to lie on the dorsomedial surface of the kidney. Sometimes one, some-

[1] This paper is taken in the main from a thesis presented by Sidney Mayer, Jr., in partial fulfillment of the requirements for the degree of bachelor of arts in the Department of Biology, Reed College, 1932.

times two, sometimes three ganglia were found anterior to the kidney in the posterior cardinal sinus; whatever the number of ganglia, rami communicantes from these ganglia to spinal nerves VII, VIII, IX, and X were found in every case. From this fact it is believed that the anterior trunk ganglia are the result of fusion in various manners of the segmental ganglia originally corresponding to the spinal nerves VII, VIII, IX and X.

The ganglia anterior to the kidney (when more than one are present) are connected one to the other by longitudinal commissures, and the most anterior ganglion on the kidney was also found to be in this chain. From the anterior trunk ganglia numerous nerves were contributed to the vagal plexus on the stomach. In addition, each anterior ganglion of either side gives a strong branch which passes mediad to the base of the coeliac artery, and then accompanies this artery in a common sheath (so that the sheath contains the artery and two sympathetic nerve cords) posteriorly to innervate approximately the region supplied by the artery. As stated before, the anterior trunk ganglia and the first ganglion on the kidney were found to be in longitudinal connection; no other longitudinal commissures nor any transverse ones were found. The ganglia of the kidney region were found on the segmental branches of the dorsal aorta.

Histological study showed that the ganglia on the anterior half of the kidney were more or less intimately associated with the suprarenal bodies; in most instances the two tissues were included within the same connective tissue capsule, but retained their identities as separate bodies within this capsule. The ganglia anterior to the kidney contained only nervous material embedded in a heavy groundwork of fibrous connective tissue containing numerous mesenchymatous connective tissue cells. No association was found between suprarenal and nervous tissue in any of these most anterior ganglia.

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Notes on Mosquito Fish in Utah, *Gambusia affinis* (Baird and Girard)

By Don M. Rees

SEVERAL attempts have been made to establish the top feeding minnow *Gambusia affinis* (Baird and Girard) in Utah for the purpose of mosquito control.

In the late spring of 1927 the Salt Lake City Mosquito Abatement District shipped from southern California about 50,000 individuals of *Gambusia affinis affinis*[1] and planted them in various fresh water pools throughout the City. They thrived and increased during the summer but all perished the following winter as none were observed in these pools in the spring and summer of 1928. In the fall of 1929, and again in the spring of 1930, these pools were carefully seined for *Gambusia,* but none were taken. To our knowledge these fish have never been successfully introduced so far north, where the winters are as severe as they are in Utah.

In May, 1929, Col. J. A. LePrince of the United States Public Health Service had a small shipment of *Gambusia* sent out from West Virginia, but these fish all died en route. Then in May, 1931, Mr. L. M. Fisher, also of the United States Public Health Service, was sent to Salt Lake City to assist the District with its mosquito control problems. Col. J. A. LePrince sent with Mr. Fisher 12 specimens of *Gambusia affinis affinis* from Selby County, Tennessee. They arrived in good condition and were kept in an inside aquarium until the first of June, when they were planted in a small outdoor fish pond in Salt Lake City. These fish were fed at intervals during the summer on mosquito larvae. They multiplied very rapidly and were allowed to remain in this pool until it began to freeze over on November 20th, when the majority, 246 fish, were returned to the inside aquarium, and about 50 were retained in the pond. During the winter the pond froze over and these 50 fish perished. All those in the aquarium passed the winter in excellent condition.

In the spring of 1932 the fish from the aquarium were planted in several ornamental pools and small ponds throughout the City. They reproduced rapidly during the summer. In the fall a few were taken inside and the remainder were planted in different types of ponds and streams in the vicinity of Salt Lake City in the hope that some would find a suitable habitat, making it possible for them to survive the winter.

The winter of 1932–33 was extremely severe. The snow was several feet deep and temperatures were sub-zero for many days. All natural ponds and streams were frozen over, except the ponds fed by the Warm Springs north of the City. In one of these warm water pools *Gambusia* passed the severe winter in excellent condition. This pool was stocked on October 14, 1932, with 14 individuals, 6 females and 8 males. This pool covers about a quarter of an acre of ground and is situated in a sheltered depression. It is fed directly from a warm water spring that flows from a tunnel at the base of

[1] Dr. Carl L. Hubbs advises the use of this name for the Mississippi Valley form, which has been acclimatized in southern California.

a mountain. The pool is from one to two feet deep with an overflow running down a little surface drain for about a mile into the large open City drain. The temperature of the water as it comes from the tunnel is fairly constant at 41° C. In the pool the temperature varies from 23° to 28° C. and in the drain it cools to temperatures but slightly above normal seasonal temperatures of surface water.

An analysis of the water taken from this pool made by N. E. McLachlan, City Chemist, shows the following:

Color—clear
Taste—salty
Odor—a slight odor of hydrogen sulphide.
Reaction—neutral to phenolphthalein, alkaline to methyl orange. The alkalinity is due to bicarbonates.

Dissolved solids	13,375	parts	per	million
Suspended solids	0	"	"	"
Loss on ignition	314	"	"	"
Silica (SiO_2)	15	"	"	"
Alumina and Iron Oxide	3	"	"	"
Calcium (Ca)	1,184	"	"	"
Magnesium (Mg)	85	"	"	"
Sodium (Na)	2,610	"	"	"
Potassium (K)	1,271	"	"	"
Sulphates (SO_4)	1,417	"	"	"
Alkalinity (Phenol.)	0	"	"	"
(M.O.)	190	"	"	"
Hydrogen Ion Concentration (pH)	8.4	"	"	"
Carbonate (CO_3)	0	"	"	"
Bicarbonates (HCO_3)	146	"	"	"

The water is highly mineralized. There is a predominance of sodium and potassium chloride with rather large quantities of sulphates.

The life in this water is rather profuse considering the nature of the water. The flora consists of sedges, *Scirpus palidosus* A. Nels., in scattered bunches around the edges. Some large mats of *Chara* (sp.?) are found growing in this pond with several species of diatoms and algae of different kinds. The fauna is varied, consisting of numerous snails, *Paludestrina longinqua* (Gould), small crustaceans of several species, and some aquatic insects principally Corixidae, Notonectidae, Dytiscidae and similar forms. Insect larvae, also abundant, consisted mainly of dipterous larvae of the families Chironomidae and Culicidae. The dipterous larvae have disappeared since the introduction of the fish.

This habitat seems to be ideal for *Gambusia* in this climate as they not only thrive but propagate throughout the year. At present there are approximately 40,000 mosquito fish in the pond and several thousand were taken from this pond and planted during the 1933 season, and many thousands have passed down the open surface drain to the City drain. This pool now affords a perpetual supply of *Gambusia* for stocking other small ponds and pools in the vicinity of Salt Lake City, and it is highly probable this supply will remain permanent.

In an attempt to determine what these fish were feeding upon during the winter in this warm water pool, 30 specimens were taken on February 9,

1934. Only adult males and females were taken. These specimens were killed immediately when taken and preserved in 10% formalin solution. The stomachs were examined within two hours after the fish were taken. The stomachs were free from any animal life but contained three different species of Oscillatoria and at least seven different species of diatoms. The bulk of the stomach contents was diatoms.

During the 1933 season many small pools were stocked with *Gambusia* and these fish were allowed to remain in these various pools during the winter of 1933–34, to see if they could survive in cold water pools. The winter was very mild and many pools did not freeze over all winter. In these open cold water pools and streams *Gambusia* survived the winter. They did not reproduce but no great losses were noticed in most of these pools when inspected on February 21, 1934, and again on March 15th. *Gambusia* passed the winter of 1933–34 with no special attention, at the following places in the City: Nibley Park, Arlington Drive, Fairmont Park, 27th South, 1st West, City Drain and several other localities. It seems highly probable that *Gambusia* may become acclimatized to live over winter in the natural habitats afforded in the vicinity of Salt Lake City. It may be necessary to re-stock some pools each spring, but this can be done at very little expense as long as an overwintered stock is obtainable.

It seems assured that *Gambusia* has been established in Salt Lake City. It has been used very successfully in mosquito control work in small ornamental ponds within the City and will be used in stocking larger bodies of water as the stock becomes available. A small stock has already been planted in the Warm Springs at Ogden, Utah, and other suitable places in different parts of the State will be planted as soon as possible.

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The Technic of Handling the Zebra Fish (*Brachydanio rerio*) for the Production of Eggs Which Are Favorable for Embryological Research and Are Available at Any Specified Time Throughout the Year

By Charles W. Creaser

UNDER this title and a similar one in two of the recent programs of the American Society of Zoologists an effort was made to introduce this extremely valuable material into experimental and student laboratories. The response has been so great that this preliminary notice has been prepared to furnish the desired information.

The zebra fish is a tropical representative of the family Cyprinidae which includes such fishes as the minnows, carps and goldfish. It is a small fish native to India (Ceylon, Bengal and Madras). In 1905 it was imported into Europe as an aquarium fish and at once it became a favorite with the fanciers. Subsequently it was brought from Europe to this country and is now raised and offered for sale by most hatcheries and dealers in tropical fishes. The cost of breeding stock is about $15.00 per 100.

It is easy to raise and breed this fish in the ordinary laboratory. The water must be prevented from reaching a temperature below 50° F or over 100° F. For the regulation of temperature many very inexpensive electric heating units and thermostats are on the market. Satisfactory combined units are also manufactured. Ordinarily the laboratory stock can be kept in a large aquarium at room temperature (70° F), or preferably higher, at about 80° F. We keep as many as 50 in a covered balanced aquarium of a size $6 \times 9 \times 26$ inches. A little plant life is desirable but not necessary.

These fishes are fed on the various kinds of prepared flake fish food sold under such trade names as Wawil, Wilot's Snowflake, and Unisono. This flake type of food they prefer and feed on best, but they can also be fed Geha and similar types of prepared food in small amounts. They should be fed often. They will live, grow, and spawn on a diet of flake food but better results are obtained if some live food is furnished. The best live foods are "White worms" (Enchytrae), Daphnia (directions for the raising of these and other live foods can be found in Hodge's *Tropical Aquarium Fishes*) and "Vestigial Winged" *Drosophila*, which we have introduced as a live food for the aquarium. The latter is the ordinary mutant genetic strain of fruit fly, raised in pint milk bottles in the manner recommended by the geneticists. It has the advantage of being unable to fly.

The method of handling the zebra fish for breeding purposes is simple. The stock fish are well fed in a balanced aquarium at 75° to 80° F in lots of as high as fifty of mixed sexes. Very soon they develop characteristics enabling the distinguishing of sex, and by their activity indicate ripening pairs. The beginner may have some difficulty in differentiating the sexes since the nature of the difference is relative rather than absolute, but a little experience is all that is necessary to make possible exact determinations. The males are usually more clearly and sharply marked, as their colors are more intense and contrasted, while the females are less sharply marked and show much less contrast of colors. This is caused in part by the frequent paleing of the blue stripes. The lowest of the three developed stripes is noticeably darker in the males than in the females, in which it is usually so obscure as to give this sex the appearance of having a much wider white ventral area than the males. Since the fish, however, often contract the melanaphores suddenly, sex discrimination on the basis of color alone is complicated. There is also much more golden yellow in the light areas, including the ventral surface, in the breeding males than in the females.

The body form of the female is plump, showing bulges on the sides when viewed from above and a rounded ventral surface when viewed from the side. The male has straight sides and ventral surface. Naturally one should not try to separate the sexes on this basis directly after feeding.

Behavior is by far the best index of a true breeding pair. The male pursues the female with a very persistent drive which the female when ripe tolerates. Occasionally a female chases other fishes but never with a really persistent drive.

Supposed pairs are isolated in breeding jars. Their activity and the deposition of fertile eggs indicate a mated pair. At times we have mated the same pair and received eggs from them every twelve to fourteen days

for several months. They are left together several days after a completed spawning, separated for a few days, then put together on the eleventh or twelfth day. Some pairs lay eggs every day for weeks if spawning is interrupted. In other instances we have returned the pairs to the stock tank after spawning and remated them when needed later. Some pairs, which for reasons difficult to determine do not spawn, are returned to the stock tank in the hope that they will spawn later.

The pair is placed in a spawning jar for breeding. The conventional type is simply a glass jar, preferably square, of a size about $6 \times 4 \times 3$ inches, on the bottom of which is placed several layers of small stones or marbles. Large stones should not be used as the fish will rush into the large spaces and may die if caught between or under large stones. The stones serve as a secure lodgement for the eggs and a protection from the cannibalistic parents. Eggs are removed with a pipette. This is accomplished most readily if the fish have been removed.

A more successful method makes use of a square glass dish with a funnel-shaped bottom. The angle must be at least 60° and the surface free of bubbles or the eggs will not slide down along the side. The bottom is constructed of glass tubing securely set 1.5 mm apart and located just below the start of the funnel shaped bottom. A rubber tube and stop cock is placed at the end of the funnel. When the eggs are laid they sink between the tubes and pile up in the lower end of the funnel where they are safe from the parents and can be drawn off through the stop cock.

When eggs are desired a ripe female and a mature male are placed in the breeding jar and the temperature allowed to increase up to 85° F or higher. This may be accomplished by exposure to direct sunlight or to lamps. During each spawning act 5 to 10 eggs are released. A female 1¼ inches long may deposit as many as 95 eggs in 15 to 30 minutes. These eggs average about 1.2 mm in diameter and are transparent, nonadhesive, and slightly heavier than water. Development starts at once and the eight cell stage in a regular development may be reached in thirty minutes. Hatching usually takes about 76 hours at a temperature of 80° F. Some individuals are much slower, others much faster in development. They will hatch in Petri dishes, Syracuse watchglasses, finger bowls, or other dishes satisfactory for observation with the microscope. Special aeration devices are not necessary. The temperature should be over 70° F for successful hatching. No difficulty from fungus is encountered because of the rapid development.

The zebra fish, in aquaria at least, have no breeding season but deposit eggs throughout the year. They have produced eggs in our laboratory in all months of the year. By keeping about 50 fish, eggs may be had at any time desired.

These eggs are being used in many types of experiments which require an easily raised vertebrate egg and are being used in our student laboratories to demonstrate the development of a living egg and the circulation of the blood.

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The Penetration of a Grouper's Digestive Tract by a Sharp-Tailed Eel

By C. M. Breder, Jr., and R. F. Nigrelli

THE grouper, *Promicrops itaiara* (Lichtenstein), is not infrequently found with curious hard, blackish, irregularly shaped objects in the visceral cavity. These are bound to the digestive tract or other parts of the viscera by folds of the mesentery. Usually, dissection fails to reveal any identifiable structure, except what seems to be a mass of more or less "cornified" tissue. They are at least clearly not parasitic cysts, both on the basis of size and structure. These curious objects have been frequently seen about the docks at Key West, Florida, where a large number of *Promicrops* may be butchered in the course of a week. The fishermen all seem to know of these objects but have no explanation for their occurrence.

A particularly large specimen was found by one of us in 1928 at Key West. It was bound to the outer wall of the stomach by thin mesentery membranes. The object was removed from a *Promicrops* measuring about four feet in length. Its appearance on removal is shown in the photograph.

It was clear from the start that this particular specimen possessed discernible structure. On softening in weak alcohol, dissection proved it to be nothing else than a "mummified" *Myrichthys acuminatus* (Gronow).[1]

The question and item of interest in this connection regards the mode of entrance of the eel into the *body cavity* of the grouper. The outstanding peculiarity of this species of eel is its hard, sharp, pointed and finless tail, which characteristic has given rise to one of its common names, "sharp-tailed eel." Anyone who has handled a living specimen, or watched one on a beach, can testify to the adroitness with which these eels can use the effectively sharp point in backing into or through things. The only likely road of entry into the body cavity by such a fish would seem to be that in the paroxysms caused by being swallowed, the sharp tail was plunged through the wall of the gut, after which it was easy and natural for the fish to follow.

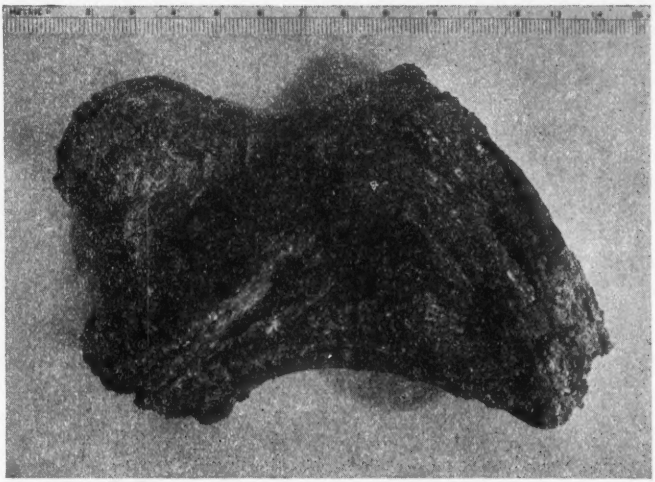
A case similar to, if not identical with, the present has been described by Deraniyagala (1932)[2] for *Ophichthus apicalis* (Bennett) found in *Serranus pantherinus* (Bleeker), *Lethrinus nebulosus* (Forskål), *L. miniatus* (Schneider), *Pristipomoides pristipoma* (Bleeker) and *Lutianus dodecacanthus* (Bleeker) as well as other but unnamed lutianids. This investigator, after introducing his remarks with reference to the inquiline *Fierasfer* and the urinophilous *Vandellia* suggests that *Ophichthus* entered the species listed voluntarily, by backing into the "cloaca." Aside from the fact that these fishes possess no cloaca, the digestive and urogenital tracts having separate external apertures, numerous objections to this interpretation may be found. Since the eels measured from 140–180 mm and the infested fishes about 600 mm, it is difficult to visualize a specimen allowing such a sized eel to force entry with only the leverage of its swimming movements. This is especially noteworthy in reference to the small bore of either orifice. The urogenital duct is definitely too small for the diameter of the eels of the length

[1] It is possible, of course, that it may be *M. oculatus* (Kaup), a more southern form separable from *M. acuminatus* on a basis of color and pattern. This was naturally no longer evident.

[2] Deraniyagala, P. E. P. 1932. A curious association between *Ophichthus apicalis* and percoid fishes. Ceylon Journ. Sci., B. (Spolia Zeylanica), 16 (3): 355–356.

mentioned, as can be attested by anyone who has attempted to catheterize such a fish. Entrance into the digestive tract would be possible, but in such a case the eel would have to puncture the intestinal wall in order to reach the coelome, as supposed for the case here described.

It is difficult to consider *Ophichthus* as a commensal within the body of a teleost under any conditions, due to respiratory difficulties. Since these eels have gills suitable for aquatic respiration and show no peculiar specialization, it can scarcely be assumed that they could long survive in the body cavity of any fish. The case of *Fierasfer* is distinctly different since it lives



The mummified remains of a two-foot *Myrichthys acuminatus* taken from the visceral cavity of a four-foot *Promicrops*.—Photograph by S. C. Dunton.

in the large cloacal lumen of holothurians, which is open to fresh sea water necessary for the respiration of the latter. *Vandellia*, on the other hand, belongs to a group notable for its ability to survive in exceptionally low oxygen concentrations. Furthermore, there is no reason to suppose that this nematognath survives in the urethra notably longer than one of these eels might in the body of a fish. On this point, a well informed collector of small tropical aquarium fish, Mr. Karl Griem, familiar with the *Vandellia* country, remarks that in his belief the danger is slight to an active swimmer and that the accidents reported are associated with resting quietly in the water for long periods.

Deraniyagala states definitely that the fishes infested feed on *Ophichthus*; ". . . . it is strange that the eel selects these fishes which prey largely on it." This certainly suggests that the entrance may have been made orally, which we consider much more likely. In order to explain the failure to find active living commensals, all being shriveled in a manner similar to the eel here figured, Deraniyagala refers to the fact that his material was obtained from a depth of from 27 to 135 fathoms. He wrote ". . . . It is possible that the living eels if present either quit their host under the discomfort of

the suddenly lowered water pressure caused by the ascent of the trawl, or they are forcibly expelled from the cloaca by the sudden expansion of the host's swim bladder."

Since Deraniyagala has found only shriveled specimens; since the eels are too large to enter the urogenital passage; since, if entrance was made by way of the anus, they would have to puncture the digestive tract, and since he mentions that these eels are eaten by the "hosts" in quantity, we are led to interpret these facts as indicating that *Ophichthus* does not voluntarily enter fishes, but its struggles after being swallowed sometimes causes it to escape into the body cavity.

The events after entering the body cavity might be one of two kinds. The eel on death, bringing with it the products of decomposition, as well as bacteria, could cause the onset of peritonitis, with the resultant death of the host. The other possibility, which is the one that certainly took place in the present case, is a walling off and the eventual reduction of the object to an inert mummified mass. Since no processes of digestion take place in the visceral cavity, the only type of reduction would be one of phagocytosis and a certain amount of solution in the body fluids. Clearly, in this case, such was insufficient to cause any important changes or even decalcification. The eel was unwrapped from its black covering in a single piece, with all the diagnostic features intact, and presented little difficulty in identification. The specimen was about two feet long, with the sharp hard tail tip still firm and strong. Since, however, the stomach wall of *Promicrops*, of the size mentioned, is particularly thick, muscular and tough, it seems unlikely that even such an eel could penetrate it before death from suffocation and digestion took place. It would seem to be more likely that penetration took place through some other part of the alimentary tract. Unfortunately, the grouper was too far butchered to permit of a search for scar tissue.

Other objects of this general type, unidentifiable, may be of the same sort. It raises the question as to what other animals may be able to perforate the gut wall, and also what the chances might be of survival of a fish suffering such perforation.

Since the black covering that envelopes these objects is necessarily the product of the living fish, in response to the intrusion of a now dead organism, a nice problem of interaction arises. In the case of encysted parasites the host may lay down a cyst wall which has been supposed to be stimulated by the secretion of some substance from the parasite.[2] As these are known to be of a fibroblastic origin, it is possible that the black membrane may be of such a type. Microscopic examination failed to be determinative, because of the nature of the material. Since we have here shown that a perfectly inert piece of dead tissue will induce "cyst" building, a question is raised as to the need for assuming the presence of a particular activating substance, in the case of intruded parasites. May not the variation in types of cysts surrounding specific parasites be referable to incidental, inherent physiological differences of the host's tissue, rather than the elaboration of definite cyst producing substances on the part of the parasite?

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[2] This does not refer to the cyst wall elaborated by many penetrating parasites themselves, but only to structures elaborated by the host proper.

Breeding Reactions in *Betta splendens*[1]

By H. B. Goodrich and Hoyt C. Taylor

BETTA SPLENDENS Regan, which is popularly known to tropical fish fanciers as the Siamese fighting fish, has been used in our laboratory as experimental material for the last four years. Certain observations on the breeding behavior and physiology, made in connection with other work, are presented in this paper.

TABLE I.
RELATION BETWEEN TEMPERATURE AND NEST BUILDING IN *BETTA*

	Temperature in degrees Fahrenheit							
	75	76	77	78	79	80	81	82
Number of males building nests.....	0	0	0	2	7	29	4	1

The fish is one of the "bubble nest builders." The male forms the nest and picks up the eggs in his mouth as they are shed and ejects them into the nest. It was found that the nest building reaction is a reliable indication that the male is ready for mating. Using this as a criterion it has been found possible by keeping the males in thermostatically controlled aquaria and by gradually increasing the temperature to determine accurately the point at which spawning occurs. Table 1 shows the results obtained from 43 observations on 41 different fish (three fish were tested twice). These results clearly indicate that 80° F is the modal point or optimum temperature for nest formation. It is of interest to note that the three fish tested twice showed the reaction at the same temperature on both tests—one making nests at 78°, a second at 79°, and a third at 81°.

Since no criterion of the readiness of the female to breed other than actual breeding has been discovered, the female reaction can not be tested in individual fish separated from a mate, as can be done with the male.

A second problem has been the determination of the frequency with which the breeding could take place. It soon became evident that the female could not breed as often as the male. Tests on the males showed that they could breed at 80° F at intervals of from two to three days. Seven males were then each mated at three day intervals and they bred respectively 4, 7, 4, 5, 4, 6, 3 times, or an average of 4.7 breedings per fish for the lot. As the number of females was limited, it is probable that some males would have bred more times had more mates been available. Testes were later examined of some of the fish killed immediately after mating. As would be expected there were relatively few spermatozoa; for the most part the cysts were filled with cells showing intermediate stages of spermatogenesis.

In order to establish the frequency of breeding in the females, tests were made with fish maintained at different temperatures. At intervals, usually of three days, females were placed with males that had built a bubble nest. If at the end of three or more days no spawning had taken place the next female was left six days, etc. In this manner the following data were obtained. Seven females kept at 80° F spawned respectively at 7, 7, 6, 8, 6, 7,

[1] This paper is published as part of a research program at Wesleyan University supported by the Denison Foundation for Biological Research.

8 days after the first spawning, or an average of seven days. Seven females kept at 70° F and placed for tests at 80° with males spawned respectively at 21, 20, 21, 21, 23, 22, 20 days, or an average of 21.1 days after the last spawning. Similarly females kept at 60° spawned at 29, 29, 27, 28, 29, 28, 30 days, or an average of 28.5 days after the last spawning. These results clearly show the effect of temperature on the spawning interval. They are summarized in the graph (Fig. 1). Since it seemed probable that the time interval was related to the rate of growth of the eggs, examinations were made to determine the size of the ova remaining in the ovaries immediately after spawning, and also in females presumably ready to spawn again. The material available was limited but the results were as follows. The average volume of the mature ova before breeding was calculated to be 2.55 cu. mm. and the volume of the largest ova in a female just after spawning was found to be 1.02 cu. mm., showing an increase of 1.53 cu. mm. between the spawning periods. Calculations based on this data give the rate of yolk deposition per day as follows: at 60° F yolk is laid down at 0.054 cu. mm. per day, at 70° at 0.073 cu. mm., and at 80° at 0.218 cu. mm. per day. These data are summarized in the broken line curve in Fig. 1.

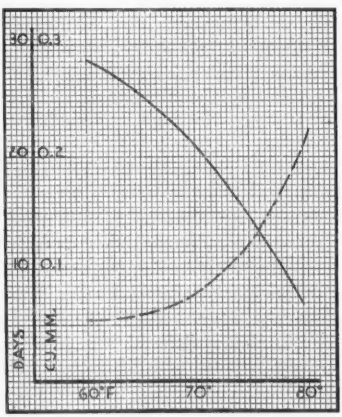

FIG. 1. Relation between different temperatures and (1) breeding interval of females in days (continuous line) and (2) rate of yolk deposition in cubic millimeters.

It is obviously not possible to make similar quantitative studies on spermatogenesis, but examinations of the testes of males held at 60° showed that development does not pass beyond the spermatogonial stage at that temperature, although the individual otherwise appears mature.

Summary.—Males of *Betta splendens* usually breed at 80° F. A few individuals may breed at points from 78° to 82°. Males may breed, at intervals of 2 to 3 days, apparently continuously at the optimum temperature of 80°.

Females will breed at intervals of 7 days at 80° F, and at uniformly longer intervals at lower temperatures. Since this interval represents the time required to deposit a known amount of yolk in the ova, the rate of yolk deposition at different temperatures can be calculated.

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Systematic Procedure in Herpetology[1]

By E. R. Dunn

HERPETOLOGY has been following the practices of Ornithology and of Mammalogy. These practices have never been definitely formulated, and recent conferences with the staff of the Academy of Natural Sciences have made it clear that there is crying need for such a formulation.

A general mode of behavior exists: evident to beginners only through their haphazard acquaintance with the literature; scarcely inferable to adepts in other fields, since the terms may be used in different senses; not at all consistent even in the restricted field of Herpetology. I hope that this situation may be improved by the following suggestions, and by the criticisms and emendations to which I hope they will be subjected. What I suggest here is derived from what I have observed in current practice. Where current practice is variable I have tried to indicate the procedure which seems to me the best, simplest, and most logical.

I have added some observations on strictly nomenclatorial matters. These are not covered by the Code and I wish to call attention to them.

The first category with which we are concerned, the individual, needs no definition. The characters of the individuals are assumed to be hereditary. This assumption is probably more nearly true in Herpetology than in most other groups, since in scutellation, and in number of vertebrae, we are dealing with features which are known not to change during life after hatching, and are probably not environmental. Also, since most of our material is alcoholic, we are not much concerned with intensity of tint, a feature sometimes known (in lions, although not in mice) to be subject to change after birth, and hence, in some cases, to be environmental. Characters known not to be hereditary are disregarded.

The individual is a member of a population which is normally connected by protoplasmic exchange with other members. The procedure applies names to populations, not to individuals. The aberrant individual may be referred to as a *freak*, or a *mutant*.

When numerous individuals differ in a similar fashion from the rest the first duty of the taxonomist is to ascertain the numerical proportion of this type in the population. This duty is usually pretty faithfully performed.

The second duty of the taxonomist is to ascertain whether these aberrant individuals are connected with the rest of the population by exchange of protoplasm. This duty, much more difficult, is often not performed at all. What is usually called "common sense," *i.e.*, considerable training and experience in the particular group, comes into play. In the majority of such cases the aberrant individuals differ in a single feature, just as do the ordinary freaks or mutants, and we assume that there is no great discontinuity in blood relationship between them and the rest.

[1] Contributions from the Department of Biology, Haverford College, No. 24.

If the proportion of the peculiar individuals is low, if they regularly mate with the others, if both appear in the same brood, the herpetologist has on his hands a *variety*. In herpetological procedure this category (important though it be to report) is not given a scientific name, although a vernacular name may quite correctly be applied to it. The terms *phase* or *strain* are often used for this category.

In herpetological procedure scientific names are applied only to entire populations of an area. Freaks and mutants, varieties, may exist within such a population, but as long as the majority of the members are alike only one scientific name is applied to the population as a whole.

Suppose that a freak or mutant increases in numbers until it forms a *variety*.

Suppose further that the aberrant individuals somewhere become so numerous as to form a very obvious majority. The population there is then *different* from the population elsewhere. It is not, necessarily, *distinct* from the population elsewhere.

There are a number of possible situations in which two populations may be different but not distinct (*i. e.*, incompletely differentiated).

1. If a single pair of contrasting characters is involved there is often a complete difference between the individuals. This is usually referred to as "presence or absence." No intergradation of *characters* can take place here, but the populations concerned may be said to intergrade as the relative proportions of individuals of the two types may change more or less gradually from a majority of one type to a majority of the other.

2. Often two varieties differ in characters which may be subjected to numerical count, or in characters of intensity of tint. Here intergradation of characters may take place by the presence of individuals whose characters are intermediate between the two extremes.

3. When more than one pair of contrasting characters is involved there may be a sort of shuffling of characters. A population composed of black and long-tailed individuals, when contrasted with a population of brown and short-tailed individuals, may be considered as incompletely differentiated if one finds black and short-tailed, and brown and long-tailed, forms. Since, in actual practice, populations usually differ in several pairs of contrasted characters, this is the most common form of intergradation.

I think the foregoing remarks cover most cases of anatomical intergradation which herpetologists meet in practice. The geographical situations need additional consideration.

The following may occur:

1. Mainland cases where the two strains occur throughout the range of the otherwise similar individuals, but where one strain forms a very clear majority in one area and the other strain is in a majority elsewhere. These are rather rare.

2. Mainland cases where both strains are present in one area, but with a clear majority of one strain, while the other strain occupies the other area in a majority of 100%. This is not common.

3. Mainland cases where the two strains occupy two different areas, in which each strain may amount to 100% of the population, but where

an intermediate area maintains a population in which the two strains occur in approximately equal numbers. Very frequently, where more than one pair of opposed characters are involved, the intermediate area maintains individuals which have some of the characters of one variety and some of the characters of the other. In this, far and away the most common situation on the mainland, the dubious individuals are confined to the area between the two incompletely differentiated populations. The prevalence of this situation has inclined a number of taxonomists to throw out all other cases of incompletely differentiated populations as incomparable, which seems to me completely illogical.

4. Insular cases in which specimens anatomically indistinguishable occur on both islands, although the majority of the two populations may be different. This corresponds with the first of the mainland cases, which is rare, while the insular situation is very common.

5. Insular cases where one island has both strains with one in a clear majority and the other island has only the other strain. This is not common.

6. Insular cases in which two islands have different strains in a majority of 100%, but where another island or the mainland maintains a mixed population. This is not common.

In all these instances intermediate characters and individuals may or may not occur depending on the number and nature of the contrasting pairs of characters. It goes without saying that neither intermediate individuals nor intermediate populations should receive taxonomic recognition.

The same phenomenon of incompletely differentiated populations occurs in all. The cases are not qualitatively different. Such populations form a category between that of the *variety,* which does not form a population at all, and that of the *species,* wherein a population is completely different and distinct. Such categories are recognized in the procedure by scientific names, and are called *subspecies* or *races* (synonymous in herpetological procedure).

Populations may be widely separated in space and still be identical. If so, they are given the same name. They may be widely sundered spatially and still be incompletely differentiated. If so, regardless of the distance apart, they should receive subspecific names. The duty of the taxonomist is to classify on the basis of anatomy, not geography.

The procedure purports to name a particular population (one set of individuals inhabiting a definite area) which differs from all others. It cannot, therefore, be utilized to designate a *series* of identical populations which have arisen independently as varieties, for if one name were used it would apply to several genetic groups, and if several names were used they would apply to identical groups. These cases are rare but they occur. The occasional colonies of red-backed and of black *Plethodon cinereus* which occur in the east cannot be named as races, although they *do* form populations. If the same variety gains the ascendancy in a number of separated areas the procedure is not adapted to the situation, and none of the populations should be named. They should be reported as varieties, and in practice they usually are so reported.

Unless well over half of the specimens can be correctly assigned to their proper population without knowledge of locality, the procedure should not

apply racial names to the two populations. No procedure can be correct in which the names do not fit the anatomical facts considerably more than half the time.

The case of *Plethodon cinereus* illustrates this point. The red-backed strain occurs throughout the range of the species, amounting to roughly 50% east of the Mississippi. In the east the black phase accounts for the other 50%. West of the Mississippi the animals are 100% red-backed. Were the proportions in the east altered so that 75% were black, the two populations might appropriately be given different racial names.

In herpetological procedure the term *species* is applied to a population which is completely differentiated from any other. A species may contain within itself freaks and mutants; varieties, phases, and strains; races and subspecies. The difference of two species in the same genus is due solely to the acquisition of different characters by the two, but the distinctness (which is the sole criterion of specific status as distinguished from subspecific status in our procedure) is usually, and I think correctly, taken as owing to the intermediates having become extinct.

Thus far systematic procedure in Herpetology may be formulated without leaving much leeway for individual opinion. If these definitions are acceptable (and they are all taken from actual modern practice) the only question on which two competent observers who have seen the same material can disagree is the percentage above 50 in a population necessary to make a race recognizable. People may disagree on what constitutes a clear majority, but this disagreement is not likely to have serious consequences, and in most mainland cases (where the intermediates are in the intermediate region) the named populations are 100% different.

It is quite otherwise with superspecific categories, and it is somewhat hesitantly that I set down the procedure that I have inferred from the literature.

The simplest superspecific group is the so-called *formenkreis*. This is a set of populations, each of which differs from all the others. No two occupy the same area, but all occupy the same ecologic niche. These populations may be distinct or may intergrade, so that a *formenkreis* may contain one or more species and one or more sets of subspecies. Each population is the representative of the others in its own territory, is the local "vicar" of the group, and is hence said to be a "vicarious" form. For these sets of vicarious populations the herpetologist is free to use the term "group," the term "*formenkreis*," or the term "subgenus." For the latter he may employ a scientific name.

Herpetological procedure does not put two "groups" of vicarious populations in separate genera unless they are thoroughly distinct. As an example, the Central American salamanders of the genus *Oedipus* form at least four such sets. No anatomical definition of them can be framed, since populations exist which would break down any definition. Had I the power to kill off certain populations of *Oedipus* I could erect four quite distinct genera in its stead. These would be as *different* as most of the other genera in the family; they are as different now, but they are not *distinct*. The taxonomist's business is not to speed up or anticipate evolution.

In short, if intermediates exist between species, the species are not species but subspecies (races). If species exist intermediate between genera, the genera are not genera but subgenera (groups, *formenkreise*).

There is another reason why a *formenkreis* should not be elevated to generic rank upon recognition as a natural group. A genus is, technically, a group of related species. A *formenkreis* is a group of vicarious populations. It may be a group of related species, but I have watched the career of many *formenkreise,* and usually they have come to consist of the various races of one species. As the intermediates have been discovered species after species has become a race, until finally the *formenkreis* has become a single species. Good procedure should maintain the term "genus" as a group of related species, and not eliminate its usefulness by rendering it synonymous with the term "species." If a genus is a group of related species a monotypic genus is almost a contradiction in terms.

Subfamilies should occupy the same relative position as subspecies and subgenera. They are different but not distinct, and can be used for groups of related genera even if strict definition is impossible. Undefinable genera and undefinable families are not good procedure.

The rules in the case of supergeneric names are extremely vague. They state that the names of subfamilies and families must end in *-inae* and *-idae* respectively. I think it a fair assumption from this statement that names not so ending cannot be considered family or subfamily names. This eliminates such names as Ceratophryes or Spelerpini.

The rules say nothing about priority in the use of supergeneric names. Procedure, however, has always (and, it seems to me, justly) tended to use the oldest available name.

The rules state that the name of the family or subfamily is formed by the addition of the terminations to the root of the name of the type genus, and that if this be changed the family name must be changed in conformity.

On this basis the proper procedure is as follows:

1. Determine the genera which constitute the supergeneric group to be named.

2. The oldest name ending in *-inae* or *-idae* which is based on any generic or subgeneric name or synonym in the group is the name for that group, unless:

3. The generic (or subgeneric) name in question is preoccupied by an older name, in which instance the proper termination applied to the root of the older name is the name for the supergeneric group.

This is actual herpetological procedure (allowing for a few exceptions) and no other can be made to agree with the statements in the Code.

If the cotypes of a species turn out to represent two different forms some revisionary restriction of the cotype series is necessary. In no other situation is discrimination between cotypes necessary, nor has it any legal sanction. It is easy to point out evils that might ensue should designation of a single type from among a group of cotypes become practice. The phrase "this is the type" might be considered type designation, although the author of the phrase might be entirely ignorant that other cotypes were in existence. Such a phrase might be used by careless writers, and their action might be

considered type designation. Such a phrase might be used in order to make a single specimen the type from motives not wholly admirable, and certainly not scientific. Many museums possess single cotypes, obtained by exchange from the possessor of the original series. I cannot think that any action whereby the single specimen is made the type, and the rest of the set in the possession of the original owner reduced to the status of paratypes, should be allowed by decent people. Fortunately, under the existing rules, there is no obligation on other workers to pay the slightest attention to any such performances.

The status of designation of type localities is exactly similar. I cannot call to mind any herpetological cases, but if any exist no one need pay any attention to them. Type localities are determined on the following bases: original description; data accompanying the specimens; collector's notes, itineraries, etc. If anyone designates a type locality on other grounds the action has no legal sanction, and need not be followed.

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A Shift of Specific Names in the Genus *Gerrhonotus*

By HENRY S. FITCH

THE specific name *multi-carinatus* was first applied to an alligator lizard in 1835 when Blainville used it in the description of a specimen sent back along with other zoological material from "Californie" (Description de quelques espèces de reptiles de la Californie: Nouv. Ann. Mus. Hist. Nat., 4: 1–64, pls. 24–27). Later writers have often used this name, but rather indiscriminately, for one or another of several of the alligator lizards which inhabit the Pacific Coast region.

In 1895, Van Denburgh applied the name *multi-carinatus* to the species of *Gerrhonotus* which inhabits the Cape region of Lower California (Review of the herpetology of Lower California. Part I. Reptiles: Proc. Calif. Acad. Sci., (2) 5: 77–163, pls. 4–14). At the same time he separated this form from the closely related species of Upper California, for which he used the name *scincicauda* (Skilton, 1849), and he gave several diagnostic characters of each species. Neither the original description of the type, nor the more detailed description of it by Duméril and Bibron (pp. 404–405 in Erpétologie générale, 1839, Paris; Roret: viii + 854 pp.) mentions any character which could not apply to both species. Van Denburgh's reason for applying the name *multi-carinatus* to the San Lucas form is not clear, but apparently it has not been questioned hitherto. My examination of numerous specimens of both forms led to the discovery of additional characters by which they may be distinguished.

Through Dr. T. I. Storer a letter written by me, in which I indicated diagnostic characters of the two forms, was forwarded to Dr. F. Angel of

of the Muséum National d'Histoire Naturelle in Paris. Dr. Angel kindly examined the type for me and found that it agreed in each of the characters which I had listed for "*scincicauda.*" The older specific name *multi-carinatus* therefore apparently should replace *scincicauda.* The latter name is, however, still applicable to a northern subspecies, inhabiting northwestern California, western Oregon, and southwestern Washington.

Gerrhonotus m. multi-carinatus, as, therefore, now re-applied, differs from the northern subspecies, *G. m. scincicauda,* in having some of the lateral caudal scales keeled (in addition to the 8 keeled rows of dorsal caudals), and in frequently having red or chestnut coloring in the transverse dorsal bands on the body, which are always black, without bright colors, in *scincicauda.*

G. m. scincicauda occurs in Klickitat County, Washington, southward through western Oregon between the Coast Range and the Cascades, and into parts of Siskiyou, Trinity, Humboldt, and Mendocino counties, California. *G. m. multi-carinatus* occurs in California throughout the Sacramento Valley, and southward along the coast to Ventura County.

Botta, who collected the type of *multi-carinatus,* did not travel within the geographic range of the subspecies *scincicauda,* but he visited many localities in southwestern and west-central California within the range of *multi-carinatus* and its subspecies, *webbii.* (See Palmer, T. S., Botta's visit to California: Condor, 1917, 19: 159–161.) That the type did not come from the geographical range of the race *webbii* is indicated by the less extensive carination of the humeral scales, only one row being weakly keeled, as I am informed by Dr. Angel. I hereby select as a type locality for *multi-carinatus,* on the basis of greatest likelihood, Monterey.

Since the San Lucas alligator lizard is left unnamed as a result of this shift, the following name is proposed for it.

Gerrhonotus ***paucicarinatus*** new species

Type.—Adult male, Museum of Vertebrate Zoology, No. 11768, collected by C. C. Lamb at Todos Santos, Lower California, Mexico; October 29, 1928.

Diagnostic characters.—Size relatively small (head and body length less than 100 mm. in adults); 50 or more transverse scale rows from ear to back of thigh; plates on top of head smooth; scales on upper arm and sides of tail smooth; labial region transversely marked with black and white; lateral fold white with reticulations of black; dorsal longitudinal scale rows on body either 16 or 14.

Museum of Vertebrate Zoology, University of California, Berkeley, California.

The Aquatic Migration of the Toad, *Bufo americanus* Le Conte

By Elliott A. Maynard

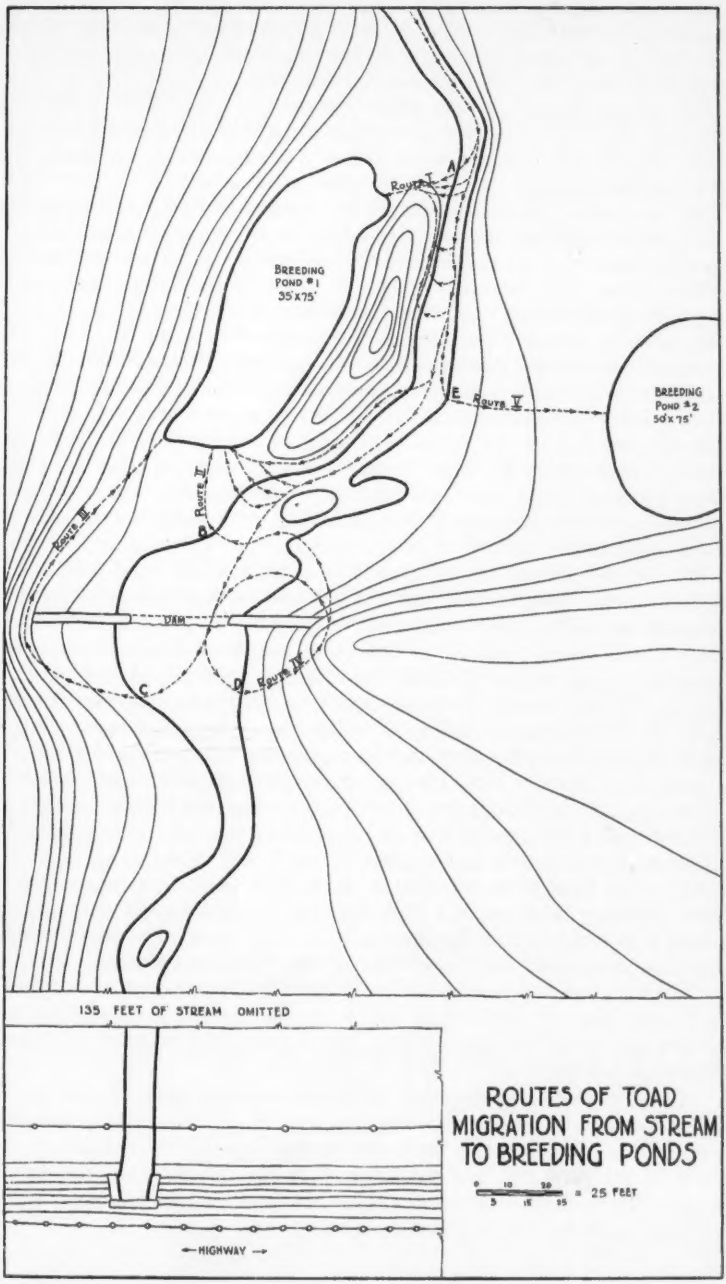
IT IS generally believed that the common American toad migrates long distances each spring in order to mate and lay its eggs in a particular pond; although in the course of its migration a toad may pass around a number of ponds that to all intents and purposes are just as well suited for breeding places. These migrations take place under cover of darkness and usually follow a cross-country route. It is also believed that an individual toad will return year after year to the same pond and furthermore that the offspring of this toad will likewise return to the locality of its birth in order to rear its family in the same situation. However, very little on this subject has appeared in the literature nor has an aquatic migration of toads ever been recorded. Therefore, in this article I shall describe such a migration just as I observed it.

To the boy who has access to a country brook, the arrival of spring and the run-off of the snow water can mean but one thing—the spring run of suckers up-stream from the lake or river for the annual spawning. Then it is that the country boy, accompanied by a companion or two, and equipped with one or more pitchforks and some sort of lantern that will throw a good light, sets forth in the gathering darkness of a brisk April evening in the hope that he may find a run of suckers in progress. While in a reminiscent mood I disclosed to one of my colleagues the pleasures that had been derived from these nocturnal expeditions many years before. It took but little urging on his part to get me interested in resuming my acquaintance with my boyhood stream. Thus it was that on the twenty-first of April, 1932, darkness and two fishermen arrived simultaneously on a small creek in the town of Greece, in Monroe County near Rochester, New York.

As we worked our way up-stream we were indeed pleased to find a small run of suckers which gave us considerable sport; but what interested me fully as much were the many toads we saw floating down-stream on the surface of the water.

A short stay netted us a liberal mess of fish and we were ready to return home. However, I recalled that another of my colleagues desired some toads for experimental purposes in the laboratory. I called to mind a small, shallow pond separated from the stream only by a narrow strip of land where many years before I had seen hundreds of toads congregated in the spring. It was but a short task to gather up all the toads in the pond, 257 in number, and depart for home, happy to know that at least one boyhood haunt remained unchanged.

This one expedition had stirred my memory and I recalled that as a boy I had often seen toads floating down on the surface of this same stream in early spring. Deciding to look further into the matter some interesting data were brought to light.


BREEDING POND #1 35'x75'
BREEDING POND #2 50'x75'
ROUTE I
ROUTE II
ROUTE III
ROUTE IV
ROUTE V
A
B
C
D
E
DAM
135 FEET OF STREAM OMITTED
HIGHWAY
ROUTES OF TOAD MIGRATION FROM STREAM TO BREEDING PONDS
0 10 20
5 15 25 = 25 FEET

For several succeeding nights visits were made to the stream and a study made of the toads. The first discovery was that the majority of the toads left the stream at approximately the same place and crossed a narrow strip of land to the pond from which I had made my collection the first night. In the illustration their place of departure is marked A to B. As shown in the illustration, a dam a short distance down stream from the point opposite the breeding pond slowed down the water and gave the toads an opportunity to swim to the quiet shallows and make their way along the routes designated as I and II. Dozens of toads were observed leaving the stream and following these lines to the breeding pond. Occasionally a toad would become caught in the swifter current of midstream and be carried over the dam. Always in such cases the toads would swim to the shallows at points C or D and make their way around the end of the dam following routes III or IV. If they followed route III they crossed the land to the pond. Following route IV they often became caught in the current when trying to cross the stream and had to make another attempt. They would sometimes try route III on the new attempt of if they re-tried route IV they could sometimes make the crossing by entering the stream at a point farther above the dam. Some individuals made repeated attempts before being successful. It was interesting to note that they seemed to have this one objective, and kept trying until they were successful in getting to the pond.

On the west side of the stream will be noted breeding pond number 2. For all practical purposes this pond should have been just as attractive to the toads as pond number 1 and yet rarely did a toad leave the stream at point E and follow route V to this pond. Only seventeen toads were collected in pond number 2 during the course of a week. (A possible explanation of the aversion for pond number 2 lies in the fact that in the spring of 1934, a season marked by the absence of the usual heavy spring rains, and a prolonged period of drought, caused this pond to dry up at an early date. But how could the toads know that such might be the case?)

On April 30, a decided rise in temperature initiated a large migration of toads that night. Arriving at the pond about an hour after darkness I took up my position so as to collect all toads leaving the water and following routes I and II. I remained in this position until I had collected 130 toads following these routes. This was the number leaving the stream during a period of about 65 minutes. Of course some few were carried over the dam and followed route III and were thus not collected.

Following this I moved up-stream, collecting all toads from the surface as I went along. I paced off as best I could a distance of approximately ½ mile and in this distance collected 190 toads or an average of one toad every fourteen feet.

It was interesting to note that of the 257 collected April 21, 218 were males and only 39 females, and that on April 30 the collections netted 53 males and 267 females. This bears out the well known fact that the males arrive at the pond first and are followed by the females. On the night of the thirtieth there were many hundreds of toads in pond number 1 that had been accumulating during the preceding week.

A trip down-stream from the dam for an estimated distance of one mile disclosed but three toads in the stream below the points marking the starting points of routes III and IV. One of these was trying vainly to work its way up-stream against the current where the stream flows through the culvert under the highway as indicated in the illustration. The other two individuals were taken from shallows in the stream and were not actually floating down the current.

I found that the toads, in migrating by the water route, simply floated along on the surface of the stream with all four legs extended.

Although the above experiences show conclusively that toads do migrate by water on occasion, there remained a number of questions that I hoped further investigation might answer.

First of all no toads were seen to enter the water to begin their migrations. I did find a number sitting quietly in the shallows. Perhaps they had entered the water at that point, but more likely they had stopped there only to resume their down stream migration shortly, for in several instances that very thing was observed. The question then remained unanswered as to where these toads entered the stream. Fortunately, on April 11, 1934, I happened to be driving along a highway that in a general way parallels the direction of flow of the stream and observed hundreds of toads crossing this road in the direction of the stream at a point approximately 2½ miles above the breeding pond. Further investigation failed to disclose another breeding pond between these two points and toads were present and could be followed in their down-stream course over the entire distance. Thus it was learned where the toads made their point of departure on their aquatic migration.

Further observations showed that none of these toads actually migrated during daylight hours and that, in 1934, it took approximately two weeks to complete the 2½ mile journey. Part of the period was cold and no migration took place on some nights. Apparently the toads left the water to feed or rest during the daytime.

How do the toads know where to leave the stream? Do some males arrive first and by their calling attract the females and other males? If so, how do the first males find the pond? And after I had removed all of the toads from the pond on April 21, what attracted the new arrivals?

On the night of May 3, 1934, the toads had completed their egg laying and every toad left the breeding pond. How do they get "back home" for their winter hibernation? It is certain they must follow a cross country route. One wonders if they spend the entire summer in their slow hopping movement over the land.

UNIVERSITY OF ROCHESTER, ROCHESTER, NEW YORK.

The Amphibians and Reptiles of Grand Canyon National Park

By Edwin D. McKee and Charles M. Bogert

OWING to the unique fashion in which the Colorado River has carved out its V-shaped canyon through a high plateau region, a greater number of life zones exist within the boundaries of the Grand Canyon National Park than would ordinarily be expected in an area of corresponding size. Within a "crowflight" distance of less than ten miles, there are represented all the life zones from Desert Lower Sonoran to timbered portions of the Kaibab Plateau which have been considered Canadian Zone.[1]

The herpetology of the region is correspondingly interesting. However, some species of reptiles regarded as good zone indicators elsewhere are not inclined to remain so strictly within their normal zones at Grand Canyon. Thus, for example, *Sceloporus magister,* normally a desert form, has been observed on the South Rim in what is usually considered the upper limits of the Upper Sonoran Zone.

The following annotated list of amphibians and reptiles known to occur within the political limits of Grand Canyon National Park is based upon the records of recent collectors as well as upon previously published records.[2] Collecting is difficult at Grand Canyon, many portions of the Canyon being relatively inaccessible, so that the list is far from being complete.

In general, the most recently accepted nomenclature has been followed.

1. *Ambystoma tigrinum* (Green): tiger salamander.—The larvae are rather common in the tanks and pools on both rims of the Canyon. One adult has been collected on South Rim. All known localities are in the Transition Zone.

2. *Scaphiopus hammondii* Baird: western spadefoot toad.—Mr. Wallace Wood noted the larvae of this species to be exceedingly abundant in Greenland Lake on North Rim.[3] This secretive spadefoot is to be expected throughout the park.

3. *Bufo punctatus* Baird and Girard: spotted toad.—Common about streams in the Canyon. Lower and Upper Sonoran Zones.

4. *Hyla arenicolor* Cope: desert tree toad.—Fairly common around shady, moist places in the Canyon and occasionally up to South Rim. Lower Sonoran and Upper Sonoran Zones.

5. *Coleonyx variegatus* (Baird): banded gecko.—Recorded from lower part of Canyon.[4] Upper limit of Lower Sonoran Zone.

[1] Randolph Jenks (Tech. Bull. No. 5 Grand Canyon, The Ornithology of the Life Zones), based upon C. H. Merriam, 1889, considers the following Life Zones to be represented within the Park: (1) Lower Sonoran (approx. altitude 2500 to 4000 feet), (2) Upper Sonoran (approx. altitude 4000 to 7000 feet), (3) Transition Zone (approx. altitude 7000 to 8200 feet), (4) Canadian Zone (approx. altitude 8200 to the summit of some of the higher parts of the Kaibab Plateau).

[2] Mr. L. M. Klauber has supplied some locality records; others are from Van Denburgh (1922), Slevin (1928), as well as from the collections of the California Academy of Science, University of California, Museum of Vertebrate Zoology, and the collection of Grand Canyon National Park.

[3] Grand Canyon Nature Notes, October, 1932: 70.

[4] Cottonwood Camp, Bright Angel Canyon—Coll. by E. D. McKee, Aug., 1929, but specimen lost at later date.

6. *Crotaphytus collaris* (Say): collared lizard.—Common in rock piles from the bottom of the Canyon to the middle of the Upper Sonoran Zone. South of Grand Canyon on the Coconino Plateau, it is not rare, so it may occur on the Plateau within the park limits.

7. *Sauromalus obesus* (Baird): chuck-walla.—Not uncommon in the bottom of the Canyon but difficult to collect because of the well-known habit of seeking refuge in cracks, which at Grand Canyon may extend several feet into the rocks. A specimen was collected at the level of the Redwall Limestone at an elevation of approximately 4500 feet, but for the most part it is a Lower Sonoran form.

8. *Uta levis* Stejneger: rocky mountain tree uta.—Common in the inner gorge of the Canyon and recorded from North Rim. The name "tree uta" seems rather inappropriate for this lizard, for the species seems to be essentially a cliff-loving one. Probably Upper and Lower Sonoran Zones.

9. *Uta ornata symmetrica* (Baird): Arizona tree uta.—Rather abundant on the walls of the inner gorge. Found in the rocks at least up to the Tonto Platform. Lower Sonoran Zone.

10. *Uta stansburiana stejnegeri* Schmidt: desert brown-shouldered lizard.—Exceedingly abundant among boulder strewn areas in the bottom of the Canyon, probably ranging up to the base of the Redwall Limestone. Confined to Lower Sonoran Zone.

11. *Sceloporus undulatus tristichus* (Cope): striped swift.—Common on both North and South Rims as well as in some of the side canyons leading down from North Rim. Upper Sonoran and Transition Zones.

12. *Sceloporus elongatus* Stejneger: Stejneger blue-bellied swift.—Found on both rims, seeming to prefer a more rocky habitat than does the preceding species. Zonal distribution not determined.

13. *Sceloporus graciosus graciosus* (Baird and Girard): sagebrush swift.—Found on both rims, also in Bright Angel Canyon. More extensive collecting, especially along Bright Angel Creek, will be necessary before the habits of the smaller species of *Sceloporus* will be well understood.

14. *Sceloporus magister* Hallowell: desert scaly lizard.—Abundant in the bottom of the Canyon, especially near the mouth of Bright Angel Creek. Occasional individuals have been observed up to an elevation slightly over 7000 feet on South Rim. Principally a Lower Sonoran reptile.

15. *Phrynosoma douglassii hernandesi* (Girard): short-horned horned lizard.—Abundant on both rims but apparently never occurs inside the Canyon walls. Upper Sonoran and Transition Zones, occasionally also Canadian Zone.

16. *Cnemidophorus sexlineatus perplexus* (Baird and Girard): Sonoran whiptail lizard. Has been collected at Roaring Springs and may be expected on the Rim inasmuch as it occurs on the Plateau to the southward, around Flagstaff. Probably Lower and Upper Sonoran Zones.

17. *Cnemidophorus tessellatus tessellatus* (Say): desert whiptail lizard.—Common in the Canyon at least up to the base of the Redwall. Lower Sonoran Zone.

18. *Coluber taeniatus taeniatus* (Hallowell): western striped racer.—Relatively abundant throughout the park except possibly on the higher areas of the Kiabab Plateau.

19. *Salvadora grahamiae hexalepis* (Cope): western patch-nosed snake. —Specimens have been secured on the Tonto Platform.[5] It seems to be a moderately rare snake here. Lower Sonoran.

20. *Pituophis sayi affinis* (Hallowell). Arizona gopher snake.—Apparently this is the commonest snake in the park. Specimens have been collected on South Rim and also within the Canyon as far down as the Tonto Platform. Specimens from the Grand Canyon Park probably should be referred to this subspecies. Principally Upper Sonoran and Transition Zones.

21. *Lampropeltis getulus boylii* (Baird and Girard): Boyle's king snake. —Not uncommon in the bottom of the canyon. A small specimen was collected near Mooney Falls, Havasu Canyon. It seems to be confined to the Lower Sonoran Zone.

22. *Lampropeltis pyromelana* (Cope): Arizona coral king snake.—Specimens have been collected along upper Bright Angel Creek as well as upon North Rim. Uncommon. Upper Sonoran and Transition Zones.

23. *Hypsiglena ochrorhynchus* Cope: spotted night snake.—Van Denburgh records a specimen from near Bright Angel Creek and one was collected on Bright Angel Point, North Rim, by S. B. Jones. Probably Upper and Lower Sonoran Zones.

24. *Thamnophis angustirostris* (Kennicott): brown-spotted garter snake. —Has been collected on South Rim only. Not common.

25. *Thamnophis ordinoides vagrans* (Baird and Girard): wandering garter snake.—Has been collected on both rims and is to be expected within the Canyon.

26. *Sonora semiannulata* Baird and Girard: bi-colored ground snake. —Specimens have been secured from the Lower Sonoran Zone at Indian Gardens, where Mr. Lloyd Davis says it is not rare.

27. *Crotalus molossus* Baird and Girard: black-tailed rattlesnake.—A single specimen was collected in Havasu Canyon (Lower Sonoran Zone) in August, 1930. This extends the known range of the species somewhat to the north of previous records.

28. *Crotalus confluentus abyssus* Klauber: Grand Canyon rattlesnake.—This species appears to be not uncommon, and rather widely distributed within the Canyon walls. Upper and Lower Sonoran Zones.

29. *Crotalus confluentus confluentus* (Say): prairie rattlesnake.—Seems to be fairly rare on South Rim. Three rattlers collected on South Rim near Desert View either belong to this subspecies or to the preceding, according to Mr. L. M. Klauber. Probably confined to Upper Sonoran Zone within the park limits.

It is expected that further collecting will enlarge this list since such forms as *Trimorphodon* and *Tantilla*, which have been collected both to the north and south, must occur in Grand Canyon.

GRAND CANYON NATIONAL PARK, AND UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA.

[5] Grand Canyon National Park Collection, two specimens.

Herpetological Notes

DIAGNOSIS OF SEX IN SNAKES.—Studies of the secondary sex characters of various species of snakes have been made by several workers. Burt (1) found in *Thamnophis s. sirtalis* that on the basis of tail length, computed as percent of total length, 11.6% of his snakes were definitely males with a tail length varying between 25.1% to 31%. Likewise 32.4% were females with a tail length of from 18.1% to 22%. Sex could not be determined in 56% of the cases because the tail lengths were intermediate between the two extremes.

Blanchard (2) described keel-like ridges on the dorsal scales of the anal region in the males of various smooth-scaled snakes; knobs on males of the keel-scaled forms, with and without ridges on the lateral edges of the anterior caudal scutes, some having in addition prominent tubercles on the scales of the chin region. With certain exceptions these characters were distinctive features of sexually mature males. Likewise Harrison (3) found that male garter snakes, *Thamnophis s. sirtalis*, of a greater length than 475 mm. characteristically possessed knobs.

As stated by Blanchard (4), it is often possible to determine sex by the shape of the tail, or definitely, by dissecting the ventral tail region immediately posterior to the vent which in the male will reveal a hollow, spiny organ, the hemipenis. An operation for the determination of sex in the living animal which is to be used for experimental purposes is obviously not practical.

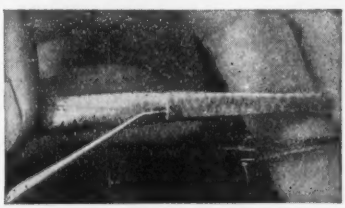


Fig. 1. Male. Showing the extent to which a probe may be inserted into the penis sheath.
Fig. 2. Female. Showing that the probe cannot be inserted.

A simple method depending upon the presence or absence of the hemipenis has been found useful in determining accurately the sexes of 93 snakes belonging to the following species: *Thamnophis s. sirtalis, Thamnophis r. radix, Elaphe vulpina, Storeria dekayi, Lampropeltis t. triangulum, Natrix s. sipedon, Coluber c. constrictor,* and *Heterodon contortrix*. The hemipenis, in its inverted position, forms two penis sheaths which open into the posterior region of the vent. A suitable probe can easily be inserted into either of these structures (Fig. 1), without noticeable discomfort or injury to the snake. A membrane covers the corresponding region of the female, and the probe cannot be inserted without injury (Fig. 2).

It is believed that investigators doing experimental or field work who are confronted with the problem of determining the sexes of snakes will find this a convenient and useful method.

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Walter H. Schaefer, *Department of Zoology, University of Wisconsin, Madison, Wisconsin.*

SCINCUS LATERALIS SAY, PREOCCUPIED.—While looking up some other matter it was discovered that the specific name for our well-known *Leiolopisma lateralis* was preoccupied at the time of its proposal in 1823. In that year Say described *Scincus lateralis* in Long's "Expedition to the Rocky Mountains" (vol. 2: 324), but unfortunately Daudin in 1803 had already incorporated a *Scincus lateralis* in his "Histoire Naturelle des Reptiles" (vol. 4: 314). This name received some currency before Say's time, thus Merrem accepted it in 1820 (Tent. Syst. Amphib.: 74) and Schinz in 1822 (Cuvier's Thierreich, vol. 2: 86). It was based on Thunberg's *Lacerta lateralis* (Kungl. Vetensk. Acad. Nya Handl., vol. 8, 1787: 126, pl. 4, fig. 2), the type specimen of which still is preserved in the Museum at Uppsala, and according to Lönnberg (Bihang Svenska Vetensk. Akad. Handl., vol. 22, sect. 4, No. 1, 1896: 36) is a specimen of the well-known Mediterranean species *Gongylus ocellatus* (Forskål, 1775).

The name next in time for our North American species is *Scincus unicolor*, established by Harlan in Journal of the Academy of Natural Sciences, Philadelphia (vol. 5, pt. 1, 1827: 156), the type locality being given as "Southern States." The valid name of the species then becomes *Leiolopisma unicolor* (Harlan).—LEONHARD STEJNEGER, *U. S. National Museum, Washington, D.C.*

THE AFFINITIES OF *DICAMPTODON* AND *RHYACOTRITON*.—The two exclusively western genera of Ambystomidae, *Dicamptodon* and *Rhyacotriton*, live in cold forest streams and clear pools during their larval stages, have a shortened larval tail-fin, and retain the lacrimal bone throughout life. In these characteristics they agree with each other but differ from *Ambystoma*. *Rhyacotriton*, however, has little superficial resemblance to *Dicamptodon*, and structurally is one of the most peculiar of all salamanders. The lungs are vestigial, the ypsiloid cartilage is absent, the carpal and tarsal cartilages do not ossify at metamorphosis, and the skull itself has a smaller proportion of bone than in any other Ambystomid. Without more evidence than this we might be satisfied that *Rhyacotriton* is a modified descendant of *Dicamptodon*, and that neither is particularly close to *Ambystoma*.

The discovery of a specialization of the skull by which the lower jaw is movable on the cranium, not only in *Rhyacotriton* but in two northwestern species of *Ambystoma*, *A. macrodactylum* and *A. gracile* (*paroticum*), led me to infer that *Rhyacotriton* is actually derived from the latter genus, and is not at all related to *Dicamptodon*. The structure consists of the squamosal, pterygoid and quadrate bones pivoting as a unit on the side of the prootic, thus allowing the lower jaw to swing forward and backward slightly, like that of a lizard. The most extreme form of this streptostylic apparatus, judged by both muscles and bones, is that in *Rhyacotriton*. A mechanism unique among Amphibia, as this is, could scarcely have been evolved twice in just the same manner, within the same restricted geographical region, and in species otherwise separated only by a generic distinction.

Clearly, then, the resemblances of *Rhyacotriton* to *Dicamptodon* have come about from two causes, an arrest of development preventing the loss of the lacrimal bone at metamorphosis, and an adaptation of the larvae to life in running brooks, resulting, for an unknown reason, in the abbreviation of the tailfin. *Dicamptodon*, on the other hand, carries the lacrimal as a primitive feature, and presumably had a shortened tail-fin and lived in brooks long before one of the northwestern species of *Ambystoma* segregated itself as a new genus, *Rhyacotriton*.—THEODORE H. EATON, JR., *Museum of Vertebrate Zoology, Berkeley, California.*

THE CAPTURE OF THE BERMUDIAN LIZARD, *EUMECES LONGIROSTRIS* COPE.—The writer recently spent a month at the Bermuda Biological Station for Research and was impressed with the easy and simple method of capture of specimens of this animal, the only native Bermudian lizard, whose centre of abundance seems to be on Castle Island. A large glass jar is sunk to its brim in the ground near rocky areas frequented by this shy and quick motioned reptile. The inner surface of the jar is smeared with butter, and the collector then withdraws. Within an hour a goodly supply of specimens are found in the jar, having fallen in while reaching down to get the butter and being unable to escape from their slippery prison.—H. L. BABCOCK, *Boston Society of Natural History, Boston, Massachusetts.*

THE ST. HELENA FROG.—My family and I landed at Jamestown, St. Helena, on the morning of July 22, 1934. I had already arranged to have a motorcar available and we began to run through the less obviously cultivated and populated sections of the Island to see if we could find any small areas undisturbed by clearing or cultivation. The windward or southeastern section was obviously the zone to cover. The leeward side of the Island supports only a semidesert vegetation, mostly of introduced species, *Opuntia* predominating. The lush, green, rainy area is surprisingly lovely. The green fields where New Zealand flax (*Phormium*) is growing are in sharp contrast to the white patches marking where the cut flax is being dried and prepared. There are high green pastures, with small brooks choked with calla lilies in full bloom, as well as great masses of flowering *Buddleya* along the roadsides. There is one stand of enormous *Podocarpus* trees very restricted in area and some of these were being cut at the time of our visit. We found no other big trees nor any other area that seemed probably undisturbed.

In this region we got beetles, land snails, isopods, earwigs, crickets and earthworms and I suppose the latter were surely introduced. Mrs. Barbour and one of the children each found a small, gray frog while digging under rotten stumps. Later on two more were found in similar situations. We heard frogs' voices from time to time, high, shrill calls not unlike those of our spring peepers but less loud and more metallic, and later on we saw enormous numbers of tadpoles in the stone drinking troughs set up for the benefit of horses and cattle by the sides of the road and into which cold springs trickled. I thought at first, more from the habits and habitat of our frogs, that we had found a *Phrynobatrachus* but on bringing the specimens home they turned out to represent *Rana grayii* Smith, a South African species. This introduction may be recent but the frogs are abundant and widespread. Mr. Arthur Loveridge tells me that his wife heard what she knew to be frogs' voices when at St. Helena in April, 1934. I have not been able to find anything about a frog on St. Helena in the few publications which I know of or which I have had time to look at. I am sending this note to COPEIA in the hope that some reader may perhaps know the story of how the *Rana* reached the Island.—THOMAS BARBOUR, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

THE SUSCEPTIBILITY OF THE NEWT *TRITURUS TOROSUS* TO ITS OWN POISON.—In connection with some work involving the thyroidectomizing of adult *Triturus torosus,* I found that these animals are highly sensitive to even small quantities of their own poison. Males in the full breeding condition are especially quick to react to the secretions from their cutaneous glands. I found that often the inserting of the needle through the skin in the course of suturing the wounds made by the operation was sufficient to bring about the death of the animal.

Washings from a vigorous male were so potent that a few drops of this liquid in ringers solution injected under the skin caused death within four to six hours. The animals so treated manifested extreme nervous sensibility, reacting violently to the least stimulus. Even a light tapping of the table on which the container holding the animals was placed sufficed to induce convulsions.

Specimens not in the breeding state do not appear to excrete so much poison. No trouble has been experienced with these animals. Males kept in the laboratory for a short time become less deadly in this respect even though they feed well and actually gain in weight.—ALFRED TAYLOR, *Department of Zoology, Oregon State College, Corvallis, Ore.*

THE MULLERIAN DUCT OF THE MALE *TRITURUS TOROSUS.*—Miss G. Smith, describing the anatomy of *Triturus torosus,* stated that there is no Müllerian duct in the male of this species. We have found, however, that while the Müllerian duct is extremely small it is nevertheless present.

Anterior to the mesonephros, on either side of the midline, there is present a narrow, opaque, white band, directly continuous with the anterior end of the Wolffian duct. There are no pigment cells along it to indicate that it might be like the rudimentary Müllerian duct of *Necturus* described by Chase, which runs along the lateral edge of the Wolffian duct. This white strand in the male of *Triturus torosus* proved to be the greatly reduced Müllerian duct. It extends ahead of the kidney to the

anterior end of the body cavity, tapering gradually until it is distinguishable only as a very thin thread of tissue. At its anterior end the Müllerian duct spreads out in funnel form, suggesting the possibility that there may be a vestigial ostium tubae, though no opening into the body cavity was distinguished. The expanded anterior end of the duct is slightly pigmented.

The Wolffian duct of the male *Triturus* ends blindly just in front of the kidney. The Müllerian duct lies in the sheath of the Wolffian duct and close to it as far as the Wolffian duct extends. From this point the Müllerian duct appears to be a continuation of the Wolffian duct unless a very close examination is made.

The Müllerian duct has a definite lumen as far as its anterior extremity. Its wall is composed of a single layer of cells with large nuclei and clear cytoplasm. Sections of the Müllerian duct at the most anterior region still show it as a small round duct with a small lumen, lying in a fold of thickened peritoneum.—LAWRENCE E. GRIFFIN and HENRY WU, *Reed College, Portland, Oregon.*

A NEW NAME FOR *LYGOSOMA* (*SIAPHOS*) *COMPRESSICAUDA* OF THE CONGO, PREOCCUPIED.—My colleague Dr. Gaston de Witte has recently described a new skink from Sandoa, Belgian Congo, under the name of

Lygosoma (*Siaphos*) *compressicauda*

(Witte, Rev. Zool. Bot. Afr. Bruxelles, 23, 1933: 175). Whether one treats *Siaphos* and *Sphenomorphus* (of which *Hinulia* is a synonym) as subgenera of *Lygosoma*, the name is preoccupied by

Lygosoma (*Hinulia*) *compressicaudum*

(Werner, Sitzber. Akad. Munchen, 1897: 210) of Australia. I would suggest, there, that the Congo skink be called

Siaphos ***dewittei***, nom. nov.

after the herpetologist who has done so much to increase our knowledge of the reptile fauna of the Belgian Congo by the rich collections he has made, and the numerous papers he has published. I would have referred this correction to him but for the fact that he is even now in the Congo and not likely to return for nearly a year.—ARTHUR LOVERIDGE, *Museum of Comparative Zoölogy, Cambridge, Massachusetts.*

THE OCCURRENCE OF *ASCAPHUS TRUEI* EAST OF THE CONTINENTAL DIVIDE.—*Ascaphus truei* Stejneger has been reported numerous times in Washington, Oregon and California. Smith[1] records the findings of a larva of this interesting anuran in a swift mountain stream in the extreme western part of Montana near the town of Haughan.

During the months of August and September, 1933, five larvae of *Ascaphus truei* were collected from the waters of Midvale Creek near Glacier Park, Montana.

Midvale Creek is a swift mountain stream at an elevation of about 5000 feet, that flows into the Missouri River drainage system from the southeastern part of Glacier National Park. A concrete dam diverts part of the water from this stream into a pipe that conducts it to the hatchery and ponds of the Glacier Park Station, U.S. Bureau of Fisheries. On August 15, 1933, a 43 mm. *Ascaphus* larva was found adhering to a rock in the bottom of one of the outside ponds at the Station. A second specimen, 48 mm. in length, was collected from this pond September 5, 1933. It is presumed that these larvae entered the pond from the stream by way of the supply pipe.

Two other unmetamorphosed larvae 44 mm. in length, and a third specimen 55 mm. in length with well developed hind legs, were collected from Midvale Creek during the last two weeks in September by Mr. Ed. Ferris and sent to the writer.

These specimens extend the known range of *Ascaphus truei* 200 miles east and north and to the eastern side of the Continental Divide.

LAUREN R. DONALDSON, *Department of Fisheries, University of Washington, Seattle, Washington.*

[1] Smith, Hobart M. COPEIA, 1932 (2): 100.

A CASE OF HERMAPHRODITISM IN *RANA CATESBEIANA* SHAW.—The records of hermaphroditism in the Anura are not rare in the literature but very few instances of such a condition have been recorded for American species (Evans, 1931). This fact may be considered of some significance in view of the large number of specimens which are examined yearly in this country. The writer is aware of only three records of hermaphroditism in *Rana catesbeiana*, the form most commonly used in laboratory studies (Clemens, 1921; Chidester, 1926; Behney, 1933).

The individual concerned in the present report was obtained from a biological supply house in Dallas, Texas. No record of the date or place of collection could be found. It is of medium size: the length from anus to tip of snout, 12.8 cm.; length of right hind leg from anus to tip of fourth digit, 18.2 cm.; diameter of tympanic membrane, 1.3 cm.; length across the mouth at the angle of the jaws, 4.8 cm.

There are no external secondary sex characters present. Vocal sacs and thumb pads are totally absent.

The external condition of the sex organs is shown in the figure. On the right side there is an almost spherical testis with a single pigmented groove on the ventral surface. The diameter of this testis is .6 cm. There are seven vasa efferentia present in the mesorchium.

There is a medium sized ovary (5.4 cm. along outside margin) on the left side. This tissue is thin and apparently underdeveloped. There is no evidence of the presence of an oviduct in the body cavity.

Histological sections were made of the testis and ovary. The sections of the testis appeared normal and were filled with mature spermatozoa. No ova were found in the organ as has been reported in other cases. The ovary contained a large number of follicles, each of which possessed several small follicular cells. No developing or mature ova were found in the female organ.

LIST OF SEX CHARACTERS

Right side	*Left side*
Spherical testis	Small ovary
One pigmented groove on testis	
Seven vasa efferentia	Many follicles present in ovary
Mature spermatozoa present	No ova seen in sections
No evidence of oviduct	No evidence of oviduct

From the above characteristics it is assumed that the specimen is a functional male with a degenerating ovary located on the left side.

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WILLIS G. HEWATT, *Texas Christian University, Fort Worth, Texas.*

CONCERNING *HEMIDACTYLUS EXSUL* BARBOUR AND COLE.—One of the most interesting novelties described from the North American continent was undoubtedly the Yucatan *Hemidactylus exsul* Barbour and Cole (Mus. Comp. Zool., Bull. L, 5, 1906: 148). Of this species Barbour and Loveridge (Mus. Comp. Zool., Bull. LXIX, 10, 1929: 274) comment as follows, "Improbable, we admit, but this seems to be a valid species. The generic identity is certain." Recently, while investigating the herpetofauna of the Yucatan Peninsula, I had reason to reopen the question of the status of this form. Upon my request Dr. Barbour reëxamined the type, and I have since gone over the specimen personally. We are agreed now that *Hemidactylus exsul* should be relegated to the synonymy of *H. turcicus* (Linné), a species known from Key West and which Dr. Barbour informs me has recently been secured in Cuba.—L. C. STUART, *Museum of Zoology, Ann Arbor, Michigan.*

NOTES ON *SONORA SEMIANNULATA* BAIRD AND GIRARD.—In addition to the specimens from Willbarger, Bexar, Travis and Tarrant counties which have already been placed on record, the Baylor University collection now contains thirteen specimens of this species which have been collected during the past few years in Baylor and McLennan counties. The Baylor County specimens, seven in number, were collected around the shores of Lake Kemp by Mr. Franklin and I, while the McLennan County specimens, three adults and two juveniles, were captured at Bluff Creek, 22 miles northwest of Waco, by Messrs. Williams and Johnson, and I.

It is unfortunate that Baird and Girard's type of *Sonora semiannulata* represents one of the variations which displays dark cross-bands, for the specific name is clearly a misnomer when applied to the color varieties inhabiting the middle section of Texas from the Wichita country south to the eastern edge of the Edwards Plateau. Cope's descriptions of the three color varieties of *Chionactis episcopus* Kennicott (*Sonora semiannulata* Baird and Girard) are as follows:

Ground color ashen to rosy, with the scales broadly tipped with brown. A few only of the median rows of dorsal scales may be red and the top of the head may or may not be brown. (The *episcopus* of Cope.)

Ground color light yellow tinged with brown above; three median dorsal rows orange. Top of head, from anterior border of frontal to near end of occipitals, black. A transverse black spot beginning on the fourth scale behind the occipitals, two scales long and including the fourth row of scales from the gastrosteges on each side. (The *Chionactis episcopus torquatus* Cope.)

Ground color ashy or red. The back is traversed by from nineteen to twenty-one black cross-bands of three and a half scales in length; there are six on the tail. Belly uniform. (The *Contia isozona* or *Chionactis episcopus isozonus* Cope, which is clearly a synonym of *Sonora semiannulata* Baird and Girard.)

The following is a list of the specimens of *Sonora semiannulata* in the Baylor University collection:

BAYLOR COUNTY: Lake Kemp, Nos. 4085, 4086, 4087, 4088, 4089, 4090, 4283:
BEXAR COUNTY; Helotes, No. 813 (five examples in poor condition):
MCLENNAN COUNTY; Bluff Creek, Nos. 2924, 2925, 3926, 3949, 3974, 5300:
TARRANT COUNTY; Cragin's Bluff, No. 4224, Hassler, No. 4621:
TRAVIS COUNTY; Dry Creek, Nos. 3979, 3980, 3981, 3982, 3983: and
WILBARGER COUNTY; Waggoner Ranch, No. 4284.

With the exception of the Helotes specimens, which are old, faded and shrivelled, color descriptions of the above snakes were written in the field. A study of these life descriptions resulted in the following conclusions:

1. Examples of *Sonora semiannulata* from central Texas (McLennan and Travis counties) lack the orange or red median dorsal stripe. A majority of the specimens from Baylor and Tarrant counties possess this stripe, but not all of them.

2. The color variety *torquatus* is rare. There are only two specimens in the series, No. 4087 from Lake Kemp, Baylor County (adult), and No. 3926 from Bluff Creek, McLennan County (juvenile).

3. Both the varieties *episcopus* and *torquatus* may or may not have brown or black heads. The black transverse spot ("half collar") may be present and the head plates unmarked. The black head markings are variable. All the large plates may be black or brown, the color may be reduced to a small crescent or v on the parietal plates, or, where the black is seemingly absent, a close examination may reveal small obsolete patches on the sides of the neck.

4. Young specimens from McLennan and Travis counties are ashen color and lack the rosy bloom of adults from the same localities and of juveniles from Baylor County.

The average total length in adults is about 250 mm. The tail ranges from 40 to 48 mm. in length.

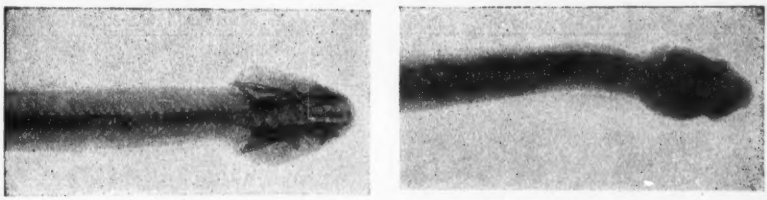
These little snakes live in rocky localities and are secretive in habits, during the day occupying burrows under stones. We had for more than five years frequently visited Blue Creek, which is less than 25 miles from Waco, without suspecting the presence of this species. Finally, in 1926, Mr. Williams found two adults there, and two years later Mr. Johnson and I captured four more specimens. They were all found under stones on the bluffs, none of them at any great distance from a small spring in a locality noted for the abundance of *Tantilla gracilis* inhabiting it. The specimens of *Sonora* were all caught on mornings after heavy rain showers. At Dry Creek, Travis County, five specimens were found under flat pieces of limestone.

At Lake Kemp, Baylor County, this species is quite common. Several gentlemen who own cottages there told me that in early spring they find one or more specimens under each of the flat stones which they turn in quest of bait. This statement may be slightly exaggerated, but Mr. Franklin and I, while collecting seven specimens under these flat stones, found the moulted skins of more than twenty-five snakes.

Sonora semiannulata feeds almost entirely on ant eggs and soft-bodied insects. In the localities where it is found are numerous colonies of ants which nest their eggs in shallows under stones, their only covering the roof of stone. In places where the earth is of sufficient depth, the serpent's burrow goes straight about four inches and then abruptly changes its course and parallels the surface of the ground. If a *Sonora* succeeds in reaching the burrow when pursued, and manages to secrete at least half the length of its body in the hole, one can seldom capture it without digging underneath, for the continued forceful efforts of the intended captor may separate the vertebrae without dislodging the snake.—JOHN K. STRECKER,[1] *Baylor University, Waco, Texas.*

REPTILE SCALES AND X-RAY PENETRATION.—Several years ago while making X-rays of two headed snakes I found some specimens which did not photograph well. Johnson[2] had made a similar observation many years earlier, and thought the poor results to be due to the reaction of the preservative on the scales.

More recently in making other X-rays of younger snakes, looking for fangs, I came across another specimen which failed to X-ray satisfactorily. That this condition could not be due to preservative seemed evident since the specimen had been dead less than a year, and other serpents preserved under similar conditions for a like period of time photographed well. A comparison of two specimens is shown in the accompanying illustration. The photographs were made on the same kind of film exposed for the same length of time, and developed with the same developer within a few minutes of



A B

Figure A, X-ray of a young water moccasin *Agkistrodon piscivorus*; B, X-ray of a young copperhead *Agkistrodon m. mokasen.* (X-ray through the courtesy of Dr. R. J. Reeves.)

each other. It seems reasonable to suppose therefore that there is considerable difference in permiability to X-ray in the scales of these two reptiles.—BERT CUNNINGHAM, *Duke University, Durham, North Carolina.*

AN INTERESTING CASE OF CANNIBALISM.—At about 9 A.M. on July 6, 1931, an immature but well-grown specimen of the San Diego alligator lizard (*Gerrhonotus scincicaudus webbii*) was placed in a small cage with an adult of the same species. This adult had been in captivity about five days and had not been fed in that time. At 4 P.M. the smaller lizard was not to be seen in the cage, but the larger one was noticeably distended in the belly region. The remaining specimen was killed and opened for examination. The stomach contained the missing lizard, doubled upon itself, and with the tail broken in several places. The adult proved to be a female with enlarged ovaries. She measured 306 mm. in total length, the body 121 mm., and the tail 185. The mark where the tail had been broken and replaced was plainly visible. The lizard which she had eaten was determined by dissection as a male. He was 282 mm. long, the body 80 mm., and the tail 202.

While cannibalism in this and many other species of lizards is well-known, this incident, because of the similarity in size between the cannibalistic female and her victim, and also because of the determination of the sex of both participants, seems worthy of record.—FRANK F. GANDER, *Natural History Museum, Balboa Park, San Diego, California.*

[1] This paper was found among the unpublished articles of Mr. Strecker after his death. At my request, Mrs. Strecker has permitted me to submit it for publication.—WALTER J. WILLIAMS.
[2] Trans. Wisc. Acad.

OBSERVATIONS ON THE EGGS AND YOUNG OF THE BLACK KING SNAKE, *LAMPROPELTIS GETULUS NIGRA* (YARROW).—At least four accounts of the eggs and young of *Lampropeltis getulus holbrooki* (Stejneger) have recently been published. Gloyd (1928: 127–128) recorded data on the laying, hatching, and average size of eggs and on the length of young. Force (1930: 32–33) gave laying dates, noted the manner of deposition and recorded measurements of the eggs. Blanchard (1932: 98) described newly hatched young and certain data on the eggs, egg tooth, ecdysis and growth. Meade (1932: 70–71) described the mating of a pair of these snakes, the eggs immediately after laying and gave information concerning the time of hatching and size of young. The scientific name does not appear in the last paper but the description and locality leave little doubt as to the identity of the form. As nothing seems to have been published on similar features of the natural history of a closely related subspecies, *Lampropeltis getulus nigra* (Yarrow), it seems desirable to place on record certain observations on sets of eggs from two snakes of this form in the collection of the Toledo Zoological Society.

TABLE I

Size of females and eggs of *Lampropeltis getulus nigra*

Clutch 1 Laid June 22, 1933 ♀ from Scioto Co.		Clutch 2 Laid June 25, 1933 ♀ from Adams Co.	
Female: length 840 mm. weight 141.8 g.		Female: length 910 mm. weight 195.4 g.	
Eggs:		Eggs:	
Measurements	Weight	Measurements	Weight
28.1 x 18.2 mm.	5.8 g.	47.0 x 21.0 mm.	
29.4 x 18.4	5.8	31.7 x 21.0	
30.0 x 18.5	5.95	43.7 x 22.2	
29.5 x 19.0	6.0	42.0 x 21.5	Adherent;
29.4 x 18.8	6.25	41.9 x 22.6	weight as
34.0 x 17.8	6.25	41.1 x 21.8	a unit—
34.3 x 18.4	6.4	42.0 x 21.1	99.2 grams
33.0 x 18.4	6.55	41.7 x 21.6	
36.2 x 17.4	6.65	42.0 x 21.6	
30.0 x 19.6	6.8		

TABLE II

Size of young of *Lampropeltis getulus nigra*

Brood 1 Hatched Sept. 9, 1933 from Scioto Co.			Brood 2 Hatched Sept. 15–16, 1933 from Adams Co.		
Sex	Length	Weight	Sex	Length	Weight
♀	235 mm.	5.7 g.	♂	237 mm.	4.1 g.
♀	236	5.4	♀	240	6.2
♀	236	6.0	♂	258	7.5
♂	237	5.4	♀	272	8.0
♀	238	5.7			
♂	241	5.9			
♂	255	6.1			
♂	258	6.2			

The first female, secured May 6, 1933, ten miles southwest of Portsmouth, Scioto County, Ohio, laid ten eggs June 22, 1933. These were capsule shaped, except for two which were pointed at one end, and were non-adherent save for two pairs cemented together along their long axes. They were cream white at first but became yellowish in a few hours. The lengths varied from 28.1 to 36.2, average 31.4 mm., the widths from 17.4 to 19.6, average 18.5 mm.: the average weight was 6.25 g. (see Table I).

The eggs were placed in a small aquarium filled with rotting wood and were kept covered throughout the incubation period by a sheet of glass. When two eggs were accidentally broken July 31, 1933, one was found to be infertile, the other contained a well formed embryo. The remaining eight hatched during the afternoon of September 9 and when examined a few hours later no egg teeth could be found. The young ranged in length from 235 to 258, average 242 mm., and showed an average weight of 5.8 g. (see Table II).

The second female was collected May 29, 1933, near Lynx, Adams County, Ohio, and deposited 9 eggs June 25, 1933. All were adherent and were arranged roughly in the same plane. In color and shape these were similar to those of the first clutch even to having two with pointed ends. Those of the second clutch were larger, however, varying from 31.7 to 47.0, average 41.5 mm., in length, from 21.0 to 22.6, average 21.6 mm., in width and having an average weight of 11 g. (see Table I).

This second set was incubated in peat moss beneath a large damp cloth. When on September 15 it was noticed that the eggs were hatching one young had emerged and another had its head thrust from the shell. Two hours later another head appeared and a fourth snake hatched the following day. After two more days, during which no further activity was noted, the remaining five eggs were opened. Four contained dead embryos and one was infertile. Lengths of the young varied from 237 to 272, average 252 mm., and the average weight was 6.5 g. (see Table II). The only egg tooth found in any of the young was seen in the third one of the second group immediately after it had ruptured the shell. When touched this specimen drew back into the egg, reappearing two or three hours later without the egg tooth.

A comparison of the dates of laying and hatching shows that the period of incubation for the first clutch was 78 days and for the second 80 to 81 days.

All of the young showed a tendency to hide under the objects occupying the cage floors. Most were aggressive when teased, vibrating their tails rapidly and striking repeatedly to the accompaniment of a sharp hiss. Both groups shed 10 to 14 days after hatching and two of the second brood shed again 55 to 57 days respectively after hatching. Twenty-five days after the appearance of the first snake it was found that the specimens of the second group had gained an average of 14 mm. in length and had lost an average of 0.7 g. in weight. About the middle of October two specimens began feeding upon young *Storeria dekayi* and *Thamnophis butleri*. At the age of two months they had attained lengths of 285 and 310 mm. and weights of 8.4 and 10.1 g. respectively.

From a comparison of these notes on *Lampropeltis getulus nigra* with similar data published for *Lampropeltis getulus holbrooki* it seems that there is little difference in these two subspecies with respect to size of eggs, period of incubation and length of the young at the time of hatching.

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Roger Conant, *Toledo Zoological Society, Toledo, Ohio.*

AMBYSTOMA TIGRINUM IN THE STATE OF WASHINGTON.—On June 18, 1932, while returning from the Pullman meeting of the Western Division of the Society of Ichthyologists and Herpetologists, I found *Ambystoma tigrinum* in Sulphur Lake, five miles east of Connell, Franklin County, Washington. This lake was called to my attention by a friend in Tacoma who told me of the very large waterdogs he had seen in Sulphur Lake. Slevin (Occ. Pap. Calif. Acad. Sci., 16, 1929: 34) reports this salamander from only two places in Washington, Colville, Stevens County, and Medical Lake, Spokane County. Sulphur Lake is eighty miles southwest of Medical Lake. All the specimens I took here were larvae, the largest of which is 7½ inches in length.

On April 5, 1934, while on a field trip with Howard Richardson, we took a number of *A. tigrinum* larvae in a small lake about ten miles north of Chelan, Chelan County, Washington. The larvae, four to seven inches in length, were very numerous in this lake but no adults were found. It is the only time that I have seen this salamander in its native habitat in the day time. This extends the known range of the tiger salamander over one hundred miles further west in the state of Washington.

While camping at Medical Lake on the night of September 4–5, 1930, I learned of an industry which was new to me. In the late afternoon I hunted the lake shore and nearby ground and could find only *Rana pretiosa*. On inquiring of a young man near the bathing beach concerning amphibians of the lake, I was told that if I would wait until eight o'clock, they would catch me some "dog-fish," meaning fish with legs. Soon after eight a number of men appeared and with a seine caught a dozen larval *A. tigrinum*. At nine o'clock two other groups came and the first disappeared. The two new groups joined forces and continued the bonfire which the first had started. The fire seemed principally to furnish light and warmth, but it may have helped to attract the salamanders to that part of the beach. These men, I suppose we should call them salamandermen instead of fishermen as they had been salamandering since the middle of July and had also worked at it during previous seasons, caught 55 that night. Two of the specimens had transformed and assumed their adult markings. They gave me these and some of the larvae. The leader of the group told me that they found a few of the colored animals from about the tenth of August until they stopped collecting; that he had taken as many as 209 dozen of the larvae in a single evening at the height of the season, and 159 individuals in a single drag of the net; that the larvae sell for fifty cents a dozen for fish bait and are almost sure bait for big fish in the larger rivers in that part of the state. The length of those taken that night was from 3 to 7 inches. These men were from Spokane and said that this would be their last trip for the year. After they had disappeared, the first group reappeared and caught another dozen larvae before leaving for the night. One of them told me that he had seen one of the adult salamanders crawling on some moist earth on the State Hospital grounds that day.

From these statements and others which they made, it would appear that the tiger salamander in Medical Lake transforms in numbers near the end of the first summer, and that there has arisen a small industry based on this salamander around Spokane, Washington.—James R. Slater, *College of Puget Sound, Tacoma, Washington.*

PHRYNOSOMA FROM FLORIDA.—Residents of the Greater Miami region frequently have remarked that "horned-toads" were to be found in the sandy lots of this locality. Southeastern Florida seemed an unusual range for these lizards.

However, during March, and again in April, of 1934, two adult specimens of *Phrynosoma cornutum* (Harlan), were presented to the reptile collection of the Tropical Biological Society by two of its members: Capt. Karl Squires, oölogist, and Mr. Henry G. Frampton, collector.—C. Ralph De Sola, *333 Central Park West, New York City.*

PLETHODON WELLERI AT WHITE TOP MOUNTAIN, VIRGINIA.—On September 8, 9, 1933, Ralph Dury, Joseph R. Bailey and the writer collected seven specimens of *Plethodon welleri* in the spruce forest at the summit of White Top Mountain, Grayson County, Virginia. Previously this salamander seems not to have been taken elsewhere than at the type locality, Grandfather Mountain, North Carolina. Our White Top specimens were secured only after a long and tedious search and we concluded that *P. welleri* is much rarer here than on Grandfather, where we had found it to be quite common on September 7. In both localities *welleri* seems to be essentially a salamander of the spruce forest, although on Grandfather a few individuals were found in the upper level of the hardwoods.

A comparison of the White Top specimens with a large series of topotypes shows only one notable difference. The former have, on the average, more conspicuously spotted venters. The least spotted individuals from White Top are inseparable from some of the topotypes, but the ventral coloration of the most strongly marked White Top examples is not approached by any individuals in a series of more than 100 from Grandfather.

Plethodon welleri seems to occupy rather an isolated position within the genus. In its small size, weak legs, and slender form it resembles *P. cinereus* and its allies, but the metallic gold dorsal pattern of *welleri* is unique, and suggests that speciation along the line of dwarfing may have occurred more than once in *Plethodon*. A single specimen of *P. cinereus* taken in company with *welleri* in the spruce forest at White Top lends some support to this view. In both localities *P. metcalfi* also occurs with *welleri*.—Charles F. Walker, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

COLEONYX IN CAPTIVITY.—During the summer of 1933, I collected a number of banded geckos (*Coleonyx variegatus*), of which two were retained for observation. These two were captured July 8 and 15, respectively. They were taken with the aid of a flashlight between 8:00 and 11:00 P. M. on a black asphalt highway on the desert in northeastern San Diego County, California.

These two specimens, like other geckos which I have kept, fed well and soon became very tame. By the middle of September, they would accept food from my fingers and would eat while sitting on my hand. They ate in broad daylight, by artificial light at night, and apparently also in the dark. Their diet consisted of a great variety of insects, principally termites, flies, and locusts. These little lizards had great appetites—the smaller one, on one occasion, eating twenty-eight large termites in rapid succession. They would often jump up from the ground in an effort to capture a butterfly or locust. Usually they caught their prey by slowly stalking it, lifting each leg in a slow precise manner, and finally making a quick grab at the victim. Before it was seized, the prey was usually tested with the tongue, as were other objects in the cage which were encountered by the lizards while prowling about.

During the summer months, whenever food was placed in the cage, the geckos would rarely refrain from coming out and devouring it. Besides the termites, flies, and locusts mentioned, they ate moths, butterflies in all three stages of growth, bees, roaches, crickets, and a few small beetles. They even ate dead insects, although it was sometimes necessary to move these about with a straw before they would be taken. On a few occasions, they ate bits of raw meat and small pellets of soaked bread which were placed on the end of a broom straw and moved about in front of them. After November 14, the geckos refused food, and up to the present writing (January 1, 1934), they have eaten nothing. Insects, such as large cockroaches, which were too big to pass through the mouth easily, were swallowed by a sidewise moving of the jaws, in the manner a snake swallows its prey.

During the time these geckos have been in captivity, they have made their home under a large rock which was placed in their cage. They dug a burrow under this rock themselves and are frequently to be seen digging in the sand of their cage. From this hole they come forth on summer evenings at about 7:00 and prowl around until near midnight. They sleep in either a curled-up or stretched-out position with the body flattened. Once one was found sleeping curled about the upper branches of a small bush placed in the cage, suggesting that they may climb to a certain extent in their native habitat.

Both geckos are still living and appear to be in good condition.—WILLIAM DERBONNE, *San Diego Reptile Club, San Diego, California.*

NOTES ON THE SALAMANDER, *PLETHODON ELONGATUS.*—Several specimens of this rare salamander were captured on November 4, 1933, a few days after the first heavy fall rain, on the north side of the Klamath River, about five miles southeast of Requa, Del Norte Co., California, on a south-facing hill slope well covered with redwood, Sitka spruce, and madroño (*Arbutus*). The salamanders were not uncommon here under rotting logs and slabs of bark; Mrs. Wood and I secured ten specimens in about an hour's search. The stomach of one of these specimens contained an undigested annelid worm about 100 mm. in length.

Under a piece of fallen redwood bark, together with an adult *P. elongatus*, were found two small, irregular clusters of salamander eggs, about 100 in number, presumably of this species. They were closely cemented together by a small quantity of viscuous jelly-like material, and were about 3 mm. in diameter, nearly spherical, but attenuated on one side to a noticeable point. Some of them contained embryos up to a size of nearly 1.5 mm.

In April, 1933, I collected in this vicinity, spending part of two days, searching this very spot. Although at that time I found other species of salamanders abundant in the region and throughout the northern coastal counties of California, careful search revealed no *elongatus*. Other likely spots in the vicinity of the type locality were examined without results as far as this species is concerned.—WALLACE F. WOOD, *7130 Chabot Road, Oakland, California.*

Ichthyological Notes

SUBSTITUTE NAME FOR *HETEROPYGE* FRASER-BRUNNER, A GENUS OF CHAETODONT FISHES.—In my recent revision of the chaetodont fishes of the subfamily Pomacanthinae (Proc. Zool. Soc. London, 1933, pt. 3), I defined a new genus under the name *Heteropyge*. Mr. Paul H. Oehser, of the Smithsonian Institution, has now very kindly pointed out that this name has already been used in Myriopoda (F. Silvestri, Ann. Mus. Genova, 38, 1897: 651), and I am indebted to him for this opportunity to correct the oversight.

I wish, therefore, to propose here the name ***Euxiphipops,*** as a substitute for *Heteropyge* Fraser-Brunner 1933 preoccupied.—A. FRASER-BRUNNER, *British Museum (Natural History), Cromwell Road, London, S. W. 7, England.*

A PREOCCUPIED NAME IN *CICHLASOMA.*—*Cichlasoma meeki* Hildebrand (Bull. U. S. Bur. Fish., 41, 1925: 275, from Lake Guija, El Salvador) is preoccupied by *Thorichthys helleri meeki* Brind (Aquatic Life, 3, May, 1918: 119, from Progreso, Yucatan), since the nominal genus *Thorichthys* is regarded as not tenable by most recent authors. Therefore, *Cichlasoma* ***guija*** (after Lake Guija in which the type specimen was taken) is proposed as a substitute. The writer is indebted to Doctors Myers and Hubbs for calling his attention to this matter.—SAMUEL F. HILDEBRAND, *U. S. Bureau of Fisheries, Washington, D. C.*

ON THE OCCURRENCE OF THE DOLPHIN FISH, *CORYPHAENA HIPPURUS* LINNAEUS, IN PANAMA BAY.—Two specimens of *Coryphaena hippurus*, respectively 81 and 90 cm. long, taken in Panama Bay about 20 miles southeast of Panama City, recently were received from Dr. Herbert C. Clark, Director, Georgas Memorial Laboratory, Panama City. Dr. Clark reports that dolphins have been taken rather frequently in Panama Bay during the past several years, both by sportsmen and commercial fishermen. The fish generally are found some distance off-shore where there is floatage, such as debris, logs, wreckage, etc., and they appear to be more or less solitary, for only one or two usually are taken at one time and place. The average length of the fish caught is around 30 inches, though much larger ones occasionally are hooked.

It has been surmised that the dolphin fish may have entered Panama Bay from the Caribbean Sea through the Panama Canal. However, 30 small specimens, 23 to 75 mm. long, were recorded from Chame Point, Panama Bay, by Meek and Hildebrand.[1] *Coryphaena hippurus*, though known from both sides of the Atlantic and from Japan, Hawaii, and California, had not been recorded from the eastern tropical Pacific previously. Since the Panama specimens on which the record cited was based were caught in 1912, it is evident that this dolphin, at least occasionally, visited Panama Bay before the Panama Canal was completed. Furthermore, California records date back to 1912.[2]

Adults probably were not secured earlier by collectors in Panama Bay because the fish apparently stay off-shore some distance and near the surface, where they ordinarily would have to be caught by trolling, a method of fishing for which the collector generally does not have or take time. Since this dolphin is widely distributed, pelagic in its habits, and generally stays some distance off-shore, it is very unlikely that it would attempt to enter the Panama Canal.—SAMUEL F. HILDEBRAND, *U. S. Bureau of Fisheries, Washington, D. C.*

ON *CARANX ANGOLENSIS* FOWLER.—In looking over material belonging to the genus *Caranx* in the American Museum of Natural History's collections I find 5 specimens from south-west Africa (probably Angola) collected by Herbert Lang about 1925, which are referable to *Caranx angolensis* Fowler, 1919.[3] As they measure from 210 to 243 mm. standard length, they are larger than Fowler's specimens, which are

[1] Field Mus. Pub. 226, Zool. Ser., 15 (2), 1925: 406.
[2] Holder, C. F., Fishes of the Pacific Coast, 1912: 97–98.
[3] Proc. U. S. Nat. Mus., 56, 1919: 280, fig. 13.

120 to 140 mm long (the figure is of a fish about 120 mm in standard length).

This is a well marked species characterized by elongate form, small teeth, numerous vertical fin rays, the last semi-detached; low curve of lateral line slightly longer than straight part, front of vertical fins little elevated, and a blackish bar across the dorsal lobe leaving its tip pale. It is rare in collections, but in 1909 I examined an old specimen 140 mm long in the Paris Museum, labelled *Caranx rhonchus* G. St. Hil., Gorée, Rang.

The figure of *Caranx rhonchus* Geoffroy Saint-Hilaire, 1826,[1] from North Africa, differs from the fish we are considering notably in a smaller head, larger teeth and in not showing the semi-detached last ray of the vertical fins or the opercular spot. It has, however, the same slender body, shape of head, configuration of lateral line and scutes, low fins, and number of fin rays which is high for this genus. It is probable that when the Paris specimen referred to was identified, authentic material of *rhonchus* was available for comparison, and not unlikely that the type figure of *rhonchus* is inaccurate. Bearing these things in mind I have been referring the Gorée specimen to *rhonchus* which gives this species a north and west African distribution. It might be safer to recognize *angolensis* as distinct until specimens clearly referable to it come to hand from the Mediterranean.

Mr. Lang's 5 specimens measure as follows.—Length to base of caudal, 210 to 243 mm. Depth in this length, 3.8 to 4.0; head, 3.4 to 3.6. Eye in head, 4.0 to 4.4. Dorsal soft rays, 31 to 33; anal, 27 to 29. Developed scutes, 27 to 28. Straight part of lateral line in the chord of the arch, 1 to 1.2. Gill-rakers, 11 to 17 + 38 to 42; totals, 53 to 55.

One of 230 mm (standard) has depth, 4.0; head, 3.6; eye in head, 4.0; snout, 3.0; interorbital, 3.5; maxillary, 2.8; greatest body width, 2.1; pectoral, 1.0; ventral, 2.0; longest dorsal spine, 2.0; longest dorsal ray, 2.5; anal ray, 3.0; caudal lobe (broken), est. 1.0.

Dorsal rays, VIII—I, 32; anal, II—I, 27. Scales, 62 + 28 scutes.

Head pointed and mackerel-like; lower jaw somewhat projecting; adipose eyelids well developed; teeth very small, seemingly in a single series in jaws. Pectoral long and falcate; soft vertical fins little elevated in front, their bases with a conspicuous sheath; their last rays somewhat enlarged and finlet-like, with bases connected with the fin. Breast scaled; arch of lateral line low, straight part 1.2 in chord of the arch; scutes developed for most of length of straight part, these moderately strong but narrow, toward the peduncle.

A small black spot at the upper corner of opercle; lobe of soft dorsal with a submarginal blackish band below a whitish tip.

This species is very like *Decapterus kurra* (Cuvier and Valenciennes) of the Indian Ocean in some respects, and seems to belong in the base of the *Decapterus* phylum, though it is more of a *Caranx* than a *Decapterus*.—J. T. Nichols, *American Museum of Natural History, New York City.*

FISH NOTES FOR 1933 AND 1934 FROM SANDY HOOK BAY AND OTHER NEW YORK LOCALITIES.—Several species appeared in Sandy Hook Bay during these two seasons that are decidedly unusual for the region.

The small fishes formerly to be found in and about the eel-grass beds were conspicuously rare. With the remarkable, complete disappearance of *Zostera* from local waters, the increasing rarity of associated fishes was perhaps to be expected. Species usually to be seined in such places and completely absent these two years include *Gasterosteus bispinosus* Walbaum, *Apeltes quadracus* (Mitchill) and *Mullus auratus* Jordan and Gilbert. *Syngnathus fuscus* Storer was rare in 1933 but fairly common in 1934. In 1934 a few stray blades of *Zostera* were noted in the harbor, called the "Horseshoe," suggesting a possible reappearance of this plant.

Items of interest from Sandy Hook Bay follow.

1. *Pteroplatea maclura* (Le Sueur).—One specimen, July 25, 1934, 217 mm to root of tail, 294 mm to tip of tail.

2. *Myliobatis freminvillii* Le Sueur.—One specimen each, on July 28, July 10, and August 29, 1934; all small, not much over a foot wide.

[1] Descr. Eg., Poiss., Atlas 9 (Zool. 2), pl. 24, fig. 1–2.

3. *Rhinoptera bonasus* (Mitchill).—More common between June 28 and October 5 in 1934 than ever before noted. The latter is a late date. On September 12 one pound net caught 42 specimens, many more than ever seen in one season before.

4. *Dorosoma cepedianum* (Le Sueur).—Two specimens each about a foot in length were taken in pound nets during October, 1933. The gizzard shad has not hitherto been recorded for the Bay, nor did Nichols and Breder (1926) have a record of it for the larger territory they included in their *Marine Fishes of New York and Southern New England*.[1]

5. *Elops saurus* Linnaeus.—A single specimen on October 11, 1934. Not taken since 1927.

6. *Hyporhamphus roberti* (Cuvier and Valenciennes).—One specimen on September 26, 1934, in company with *Strongylura marina* (Walbaum). Taken in this locality but once before, in 1932.[2]

7. *Sphyraena borealis* De Kay.—Two specimens taken on October 23, 1934, 115 and 140 mm in standard length. Not noted since 1928.

8. *Lutianus griseus* (Linnaeus).—A single small specimen of about 60 mm taken September 26, 1934. A new record for Sandy Hook Bay.

9. *Orthopristis chrysopterus* (Linnaeus).—One specimen taken on August 28, 1934. Not noted since 1925.

10. *Rachycentron canadus* (Linnaeus).—One large specimen of about three feet on July 10, 1934, and a young one of 150 mm in standard length, 170 mm total length, on September 20. At this size the tail form of the adults is evident. At a total length of 98 mm the tail is spatulate, as figured by Breder.[3]

11. *Alectis ciliaris* (Bloch).—Specimens taken in 1934 on July 25, and September 20 and 27.

12. *Chloroscombrus chrysurus* (Linnaeus).—Several specimens were taken in pound nets during September, 1933. A new record for Sandy Hook Bay. There must have been a somewhat coastwise influx of this species, as it appeared rather commonly among market herring brought to the Aquarium for food.

13. *Trachinotus carolinus* (Linnaeus).—Large specimens were unusually common during 1933 and small examples were more abundant than for several years. No large ones were taken during 1934 and small ones once again became scarce, being taken only on October 23.

14. *Trachinotus falcatus* (Linnaeus).—More common than usual. Small specimens August 28 and 30, 1934. Apparently more common about Islip, Long Island. Several specimens were brought from that region by Mr. K. Atwood 3rd.

15. *Trichiurus lepturus* Linnaeus.—Two specimens were collected July 11, 1934. Only taken once before in this region.[2]

16. *Chaetodipterus faber* (Broussonet).—One large example July 25, 1934. Not noted since 1930.

17. *Balistes carolinensis* Gmelin.—One specimen October 18, 1934. A late record. Not noted since 1925.

18. *Alutera schoepfii* (Walbaum).—Large ones common in 1934. Two small specimens 230 and 180 mm in standard length.

19. *Lagocephalus laevigatus* (Linnaeus).—More numerous both seasons than for several years. September 20 to October 11, 1934.

20. *Astroscopus guttatus* Abbott.—Two specimens of about ten inches were taken in pound nets in October, 1933. Formerly known from Sandy Hook Bay on the basis of very small examples only. J. T. Nichols recorded that two large specimens were

[1] Nichols, J. T., and Breder, C. M., Jr., Zoologica, 9 (1), 1926: 1–192.
[2] Breder, C. M. Jr., COPEIA, 1932 (4): 180.
[3] Breder, C. M. Jr., Bull. N. Y. Zool. Soc., 29 (6), 1926: 179–180.

obtained from the New York market for the American Museum of Natural History in November of the same year, the largest twelve inches in standard length and fifteen inches in total length. Another, and similar one, was brought to the Aquarium from Oyster Bay, Long Island, on July 13, 1933.

This list adds three species to the fish fauna recorded from Sandy Hook Bay: *Dorosoma cepedianum, Lutianus griseus* and *Chloroscombrus chrysurus,* bringing the total to 125.

Both seasons saw a rather unusual influx of more southern fishes, as the various items indicate. Flying fishes were seen, and one taken on the Long Island shore, an example of *Parexocoetus mesogaster,* was reported by J. T. Nichols, who also recorded *Gymnosarda pelamis* as being encountered by the tuna fishermen.[1] Items of interest from other New York localities include:

Albula vulpes (Linnaeus).—Long Island Sound, October, 1933, about two feet.

Epinephelus niveatus (Cuvier and Valenciennes).—Long Beach, Long Island, September 24, 1933, about four inches long.

Priacanthus arenatus Cuvier and Valenciennes.—A specimen taken by Mr. Eugene Thurston, twelve miles off Fire Island, Long Island, on August 18, 1933, was deposited in the American Museum of Natural History (J. T. Nichols).

Pseudopriacanthus altus (Gill).—Several from Long Island Sound, September, 1933, about one inch long.

Balistes vetula Linnaeus.—A specimen taken by M. A. Melos at Freeport, Long Island, on October 5, 1933, was deposited in the American Museum of Natural History (J. T. Nichols).

We are indebted to Mr. J. T. Nichols for permission to include the several records which are credited to him.—C. M. Breder, Jr., and R. F. Nigrelli, *New York Aquarium, Battery Park, New York City.*

[1]Nichols, J. T. Nat. Hist., 34 (7), 1934: 678.

Reviews and Comments

TROPICAL FISH. By Lucile Quarry Mann. Leisure League of America, 30 Rockefeller Plaza, New York City, 1934: 96 pp., 13 pls. 25 cents.—A very creditable addition to the large and still growing list of pamphlets and books for aquarists. . . . This is a work addressed mainly to the beginner, yet there is nothing about it with which the expert could find fault. Mrs. Mann knows her fishes and aquarium principles. Being an experienced writer, and one of those rare ones capable of stating simple things simply, her booklet cannot be other than one which will fulfill its purpose in a clear and helpful way. The contents include The Aquarium, The Live Bearers, The Bubble Nest, Builders, The Egg Layers, Aquarium Oddities, Aquatic Plants, Diet and Disease. The illustrations . . . have the rather unusual distinction of not being copies. . . . This pamphlet is a sound stepping stone on which the beginner can safely bear his weight.—From review by W. T. Innes, in *The Aquarium*.

MANUAL OF THE VERTEBRATE ANIMALS OF NORTHEASTERN AND CENTRAL CHINA, EXCLUSIVE OF BIRDS. Contributions to the Teaching of Biology from Ginling College. By Cora D. Reeves. Chung Hwa Book Co., Ltd., Shanghai, 1933: 806 pp., 169 text-figs.—This book aims to give classification and description of each of the known vertebrate animals other than birds (that is to say fishes, amphibians, reptiles and mammals) to be met with in the area treated. It is designed to enable students to identify by name the animals in which they are interested. The author's experience in teaching has shown her what sort of book would be most helpful and this is an attempt to fill the need. More than three-quarters of the text deals with marine and fresh-water fishes, the largest group considered.

The volume unfortunately contains many imperfections, which seem in part due to the difficulty of steering between differences of opinion in which the subject at present abounds, in part to the author's being primarily a teacher rather than a taxonomic biologist. There are also typographical errors which one must guard against. The plan of the book is excellent for its purpose. Size, make-up and type render it convenient for reference. The many illustrations add to its attractiveness and value, even though various of them leave much to be desired as illustrations of fishes.

At the present time the vertebrate animals of China are receiving a great deal of attention. Large collections made recently are being studied abroad, and at home a host of intelligent young Chinese have an awakened interest in the fauna of their own land, the study of which also affords them a convenient threshold to modern scientific thought and method. We are passing rapidly from a fragmentary and disorganized to a comprehensive and organized knowledge of a broad subject. There could scarcely be a time when it would be more difficult to write such a manual, or, for that matter, when one would be more useful. Dr. Reeves is primarily to be congratulated on her courage in undertaking and completing the task.—J. T. Nichols, *American Museum of Natural History, New York City*.

NOTES ON FISHES IN THE ZOOLOGICAL MUSEUM OF STANFORD UNIVERSITY—1. THE FISHES OF THE HERRE PHILIPPINE EXPEDITION OF 1931. By Albert W. C. T. Herre. 106 pp., 16.5 x 25 cm. Printed by the Newspaper Enterprise, Ltd., Hong Kong, China, March 10, 1934. Edition limited to 120 copies.—This paper is the record of a remarkable expedition, interesting not only as an indication of the richness of the Philippine fish fauna but also as proof of Dr. Herre's extraordinary ability as a collector. The reviewer had the good fortune to be associated with Dr. Herre during the time he was studying this collection and to examine personally a good many of the 1021 species listed. Thirty-three of the species were considered by Dr. Herre to be new, of which seventeen, including a new genus of gobies, were previously described in Copeia. Three new genera (two of gobies, one of platycephalids), 16 new species, and one new subspecies are published for the first time in this paper.

The nomenclatural status of the present contribution, as a privately printed paper,

deserves some comment. Due to the almost prohibitive cost of printing in this country, Dr. Herre had the report printed in China during the time he was in that country on his recent round-the-world expedition. Cost also forced him to limit the edition to only 120 copies. Although the *printer's* name and date of *printing* appear in the paper, no *publication* place or date is given. That there may be no further confusion concerning this, I wish to state that 75 copies were mailed from Hong Kong to workers active in Indo-Pacific ichthyology. Further, the Hong Kong postmark on the envelope containing the reviewer's copy was dated March 10, 1934, showing that copies were distributed on the stated date of printing. A few copies are still available from the author at Stanford University, California, at a price of $2.00 each, and workers and institutions who need what is sure to become one of the rarest items in ichthyological literature should communicate with Dr. Herre immediately.—GEORGE S. MYERS, *U. S. National Museum, Washington, D. C.*

LIFE AND LOVE IN THE AQUARIUM.—By C. H. Peters. Empire Tropical Fish Import Co., New York City: $3.75, 1934, 399 pp., 42 figs., 61 halftone pls., 25 col. pl.—Written by a well-known fancier, editor of the popular *Home Aquarium Bulletin*, this new book lives up to expectations in providing a very readable and interesting account of aquarium fish lore. In unstilted and enthusiastic language the author presents a series of short chapters or articles, treating the great and growing tropical fish hobby; the home aquarium and its care; aquarium plants—kinds, value, and arrangement; food; scavengers; trouble; enemies; "the more extensive collection," etc. A chapter on *Lighting the Aquarium* was contributed by the authority on the subject, Arthur J. Sweet, while an appendix on the popular subject of pH Control of Aquarium Water was prepared by Oliver M. Black. The general aspects of aquarium science are more thoroughly treated than usual, and the suggestions are more understandable and helpful. The greater portion of the book is devoted to descriptive and cultural accounts of individual species, stressing the few popular ones but including also many rare aquarium fishes. The arrangement and classification of this material could be improved, though starting with the familiar and easy-to-rear livebearers is commendable. Ichthyologists will be more concerned than the fancier or the general reader over rather numerous technical errors, especially in the spelling of scientific names. Some of these errors are common to aquarium literature, as the use of *Platypoecilia* for the genus properly called *Platypoecilus*, while others are original, or merely typographical. A number of other slips, as under "habitat," are noticeable. These minor defects could be corrected before a new edition is printed, as also the failure to give any text to correspond with the figures of certain species. It is indeed surprising that one not trained in ichthyology should use such accurate and up-to-date nomenclature. The book is bountifully and beautifully illustrated by Henry Uhlig. The colored plates, especially, are in general very charming and true to life. Both these and the halftone plates usually show several species, facilitating comparisons and identification. The typography and binding is pleasing.—CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

EDITORIAL NOTES AND NEWS

Herpetological Items

DR. DORIS COCHRAN, of the U. S. National Museum, has been invited by Dr. Adolpho Lutz, of the Instituto Oswaldo Cruz, to cooperate with him in writing the text of his "Frogs of Brazil," for which superb colored plates have been already prepared. Dr. Cochran sails for Brazil on January 5, where she will spend four months in compiling Dr. Lutz's invaluable notes on life histories and habits, and in visiting his type localities to collect topotypic material for the U. S. National Museum.

A recent copy of Science Notes from the College of Natural Science, Yenching University, Peiping, China, announces an interesting plan for research work in biology. Beginning this year (1934–5) all student thesis topics for a given year will focus on different biological phases of a single subject. The *Kaloula* (rain frog), common about Peiping, is being studied this year.

Some American herpetologists may not realize that the separate divisions of the Zoological Record are to be had at a very reasonable price. The Record for 1933 is now out, and anyone desiring a copy of the division for Amphibia and Reptilia should address the Zoological Society of London, enclosing postal money order for three shillings and twopence, which includes postage.

News of Ichthyologists

DR. HUGH M. SMITH has recently returned to America from Siam, where for years he was head of the Siamese Fisheries Department. He has brought with him a collection of Siamese fishes, although the bulk of his material was left in Siam. He is now working in the United States National Museum.

Prof. T. D. A. COCKEREL of the Zoology Department, University of Colorado, has recently retired with the title of Professor Emeritus.

LUIS HOWELL RIVERO, of the University of Havana, has recently begun work at the Museum of Comparative Zoology under a Guggenheim Fellowship. He will continue here his studies of West Indian fishes.

New Pollution Menace

A RECENT *Fisheries Service Bulletin* discusses a surprising project by the city of St. Louis, for the disposal of its 600 ton daily garbage supply into the Mississippi River, in ground form. This assinine project has rightly called for an investigation by Dr. M. M. ELLIS to determine, for the U. S. Bureau of Fisheries, the probable effect of this proposed practice on the river and on its aquatic life. A real menace is indicated. When will Americans learn to take advantage of the potential value of such biproducts of city life, rather than to throw them into streams, thus destroying other resources and economic values? An awakening of public conscience of the pollution problem is evident. Under a public works project, Dr. Ellis and staff have been busy through the year investigating stream pollution through the Mississippi Valley. The AMERICAN FISHERIES SOCIETY has sponsored, with other organizations, an extensive study of the general problem, leading toward policy and action.

Stream and Lake Improvement

THE new activity of lake and stream improvement, designed to increase the production of food and game fishes in natural waters, is rapidly expanding. The U. S. BUREAU OF FISHERIES announces the completion in both the East and the West of stream and lake surveys undertaken to furnish not only a stocking program but also improvement recommendations. The Bureau undertook some experiment work along this line, and the Forest Service and several states put the new principles into extensive practice in various parts of the country, generally making use of relief labor. J. W. LEONARD has joined the staff of the Institute for Fisheries Research at the University of Michigan, to conduct investigations leading to an evaluation of the effects of such environmental control on the streams and the fish life.

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